AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Materiel Command Deputy Chief of Staff for Science & Technology. The Air Force SBIR Program Manager is R. Jill Dickman. Do NOT submit SBIR proposals to the AF SBIR Program Manager under any circumstances. Inquiries of a general nature or problems that require the attention of the Air Force SBIR Program Manager should be directed to her at this address:

Department of The Air Force
HQ/AFMC/STXB (AF SBIR Program Manager)
4375 Chidlaw Rd
Suite 6
Wright-Patterson AFB OH 45433-5006

No additional technical information (this includes specifications, recommended approaches, further refinement, the limiting of topic areas, and the like) can or will be made available by Air Force personnel during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Information is key to successful proposal preparation and research; however, locating pertinent information is often difficult. For this reason the DoD SBIR Program is working on better ways to serve the small business community with information support. In this solicitation Phillips Laboratory is participating in a pilot reference information project by supplying, in most cases, up to 5 technical references that provide background or insight to the topic. Additional references are available for each topic in the Technical Information Packages (TIP) prepared by DTIC. Please refer to section 7.1 in this solicitation for further information on DTIC.

The maximum amount of SBIR funding used for any Air Force Phase I award shall be $60,000. Also firms are encouraged to submit a proposal for an option task which would be performed during the period between Phase I completion and Phase II contract award not to exceed $20,000. The basic Phase I proposal shall be evaluated exclusive of the option task and must therefore be proposed and priced separately. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and shall not be included in the basic Phase I limitation to not exceed 25 pages. The option shall detail work that would logically transition a feasibility determination during Phase I into a practical application during Phase II. The transition work shall be included as an option in the Phase I contract and evaluated for unilateral Air Force exercise at any time after Phase I award through the conclusion of the Phase I contract reporting period. Exercise of any option shall be at the sole discretion of the Air Force and shall not obligate the Air Force to make a Phase II award. It is anticipated that the option portion of the proposal shall be 10 pages or less, not exceed $20,000, not exceed 3 months in duration, and be evaluated using the same evaluation criteria as for Phase I. Any resultant Phase I contract containing an option shall include a provision that sets forth the Air Force right to obtain the option effort at the previously agreed to price by providing written notice of same on or before the conclusion of the Phase I contract reporting period.

PROPOSAL SUBMISSION INSTRUCTIONS

For each Phase I proposal, send one original (with red appendices A and B) and three (3) copies to the office designated below. Also, send an additional set of red appendices A and B, which are not stapled or mutilated in any way. Be advised that any overnight delivery may not reach the appropriate desk within one day.

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS (Name and number for mailing proposals and for administrative questions)	CONTRACTING AUTHORITY (For contractual questions only)
AF94-001 thru AF94-006	Arnold Engineering Development Center AEDC/DOTP Arnold AFB TN 37389 (Kevin T. Zysk, (615) 454-6507)	Dowe Jones (615) 454-4423
AF94-007 thru AF94-013	Air Force Office of Scientific Research AFOSR/XPP (Chris Hughes) 110 Duncan Avenue, Suite B115 Bolling AFB DC 20332-0001 (Chris Hughes, (202) 767-5015)	Harry Haraldsen (202) 767-4990
AF94-014 thru AF94-036	Armstrong Laboratory AL/XPTT 2509 Kennedy Circle Brooks AFB TX 78235-5000 (Belva Williams, (512) 536-2838)	Sharon Shen (512) 536-9393
AF94-037 thru AF94-068	Rome Laboratory RL/XPX 26 Electronic Parkway Griffis AFB NY 13441-4514 (Robert Falk, (315) 330-2912)	Mary Lovett (315) 330-2804
AF94-069 thru AF94-078	Phillips Laboratory - Space & Missile Technology Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Room 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Roger Shinnick (505) 846-5935 Ext 147
AF94-079 thru AF94-083	Phillips Lab - Advanced Weapons & Survivability Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave. S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Rudy Fourzan (505) 846-6877

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF94-084 thru AF94-092	Phillips Laboratory - Rocket Propulsion Directorate OL-AC Phillips Laboratory/TO (Attn: Ms Sandra Borowiak) 5 Pollux Dr., Bldg 8419 Rm 12 Edwards AFB CA 93524-7048 (Ms Sandra Borowiak, (805) 275-5617)	Ms. Donna James (805) 277-8813
AF94-093 thru AF94-098	Phillips Laboratory - Geophysics Directorate OL-AA Phillips Laboratory/XPG 29 Randolph Rd, Bldg 1107 Rm 240 Hanscom AFB MA 01731-3010 (Noreen Dimond, (617) 377-3608)	Mr. John Flaherty (617) 377-2529
AF94-099 thru AF94-105	Phillips Lab - Ballistic Missile Organization PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave. S.E. Kirtland AFB, NM 87117-5776 (Ms Della Hinesley, (714) 382-5371 or Bob Hancock, (505) 846-4418)	Mr. Roger Shinnick (505) 846-5935 Ext 147
AF94-106 thru AF94-113	Phillips Laboratory - Lasers & Imaging Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Dave Tuttle (505) 846-8133
AF94-114 thru AF94-115	Phillips Lab - Operations And Plans & Programs Directorates PL/XPI (Attn: Bob Hancock) Bldg 497 Room 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Maj Ron Unruh (505) 846-1346
AF94-116 thru AF94-118	Phillips Laboratory - Space Experiments Directorate PL/XPI (Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Maj Ron Unruh (505) 846-1346

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF94-119 thru AF94-133	WL/AAOP Bldg 22 2690 C St, Ste 3 Wright-Patterson OH 45433-7410 (Sharon Gibbons, (513) 255-5285)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-134 thru AF94-141	WL/ELA Bldg 620 2241 Avionics Circle Ste 29 Wright-Patterson, OH 45433-7331 (Howard Romaker, (513) 255-6723)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-142 thru AF94-157	WL/FIOP BLDG 45 2130 Eighth St, Ste 21 Wright-Patterson, OH 45433-7562 (Madie Tillman, (513) 255-5066)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-158 thru AF94-172	WL/MLIP BLDG 653 2977 P St Wright-Patterson, OH 45433-6523 (Frank Borasz, (513) 255-7175)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-173 thru AF94-187	WL/POMX Bldg 18 1921 Sixth St Ste 5 Wright-Patterson OH 45433-7650 (Betty Siferd, (513) 255-2131)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-188 thru AF94-192	WL/MTX BLDG 653 2977 P St, Ste 6 Wright-Patterson, OH 45433-7739 (Timothy Swigart, (513) 255-7363)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-193 thru AF94-198	ASC/XRP, Bldg 56 2100 Third St Ste 2 Wright-Patterson OH 45433-7016 (Fred Strawn, (513) 255-6673)	Arnette Long (513) 255-6134
AF94-199 thru AF94-204	Wright Laboratory - National Aerospace Plane ASD/NAF Wright-Patterson OH 45433-6523 (Dr. Kervyn Mach, (513) 255-1858)	Cathy Doyle (513) 255-9637
AF94-205 thru AF94-226	Armament Directorate WL/MNPB 101 West Eglin Blvd, Suite 143 Eglin AFB, FL 32542-5434 (Richard Bixby, (804) 882-8591	Lyle Crews, Jr (904) 882-4284

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF94-227 thru AF94-235	ASC/SMEM, Bldg 22 2690 C St, Ste 5 Wright-Patterson AFB, OH 45433-7412 (Bob Andes, (513) 255-3442)	

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AF94-025 Biological Methods for Complete Destruction of Nitro- Substituted Contaminants

AF94-026 Landfill Remediation Techniques

AF94-027 Concentrated Oxygen and Storage Technologies

AF94-028 Human Sensory Feedback in Air Force Telerobotic Systems

AF94-029 Crew Protection Systems

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AF94-036 Improvements in Life Support Personal Protective Equipment and Altitude Diagnostic Technology

ROME LABORATORY, GRIFFISS AFB NY

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PHILLIPS LABORATORY - SPACE & MISSILE TECHNOLOGY DIRECTORATE, KIRTLAND AFB NM

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PHILLIPS LABORATORY - ADVANCED WEAPONS & SURVIVABILITY DIRECTORATE, KIRTLAND AFB NM

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PHILLIPS LABORATORY - ROCKET PROPULSION DIRECTORATE, EDWARDS AFB CA

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PHILLIPS LABORATORY - BALLISTIC MISSILE ORGANIZATION (BMO), NORTON AFB CA

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WRIGHT LABORATORY, SOLID STATE ELECTRONICS DIRECTORATE, WRIGHT-PATTERSON AFB, OH

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AF94-192 Carbon-Carbon Manufacturing

WRIGHT LABORATORY - AERONAUTICAL SYSTEMS CENTER, WRIGHT-PATTERSON AFB OH

AF94-193 Acquisition Management Information Analysis Center (AMIAC)

AF94-194 New Concepts & Innovations for Aeronautical Systems/Subsystems

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AF94-197 ENSIP Inspection of Engine Components

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WRIGHT LABORATORY - NATIONAL AEROSPACE PLANE JOINT OFFICE, WRIGHT PATTERSON AFB

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WRIGHT LABORATORY - ARMAMENT DIRECTORATE, EGLIN AFB FL

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TECHNOLOGY TRANSITION OFFICE, WRIGHT-PATTERSON AFB OH

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AF94-229 Remote Determination of Composite Chemical Characterization

AF94-230 Mass Producible, High Intensity, Subminiature, Infrared Emitters/Sources

AF94-231 Laser Photography of Explosive Events

AF94-232 Contaminated Soil Remediation Utilizing Photoelectric and Thermal Energy

AF94-233 Automatic Sensor Distinguishing between Biological and Petrochemical Fuels

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SUBJECT/WORD INDEX TO THE AIR FORCE SBIR SOLICITATION

AIR FORCE TOPIC DESCRIPTIONS

AF94-001TITLE:Rain Erosion For Engine Airframe Component Testing

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a technique to simulate erosive rain environments for testing of aircraft components and materials.

DESCRIPTION: Liquid water in the form of droplets on the order of one to one-and-a-half millimeters in diameter can exist in the atmosphere. Aircraft encountering these drops can be subject to erosion of forward facing surfaces. A facility that can provide a sustained simulation of erosive rain is needed. The goal of this effort should be to conceptualize and develop a technique to achieve erosive rain simulation in a test facility at the Arnold Engineering Development Center. The simulation should be applicable to a 12 to 18 inch diameter freejet test facility. The simulation should cover flight speeds in the subsonic regime from Mach 0.3 to 0.9. The simulation technique must be expandable to facilities where larger test articles can be tested. The facilities envisioned are on the order of three to four feet in diameter at the test section.

Phase I: Phase I should identify the governing parameters of subsonic erosive rain simulation. A technique to simulate the erosive rain should be conceptualized and demonstrated on a subscale basis.

Phase II: Phase II should result in the hardware and a technique needed to provide realistic erosive rain simulation in AEDC test cells.

Dual Use Commercialization Potential: This project has commercial applications in the development of advanced materials and abrasion resistant coatings. Derivative technologies may be applicable to cleaning or machining industries.

AF94-002TITLE:Smooth Ultrahard Coatings On Metals

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a technique to produce smooth ultrahard surfaces on machined metal surfaces.

DESCRIPTION: Arc heater segments fabricated from oxygen free high conductivity copper (OHFC) need an effective means of dissipating high heat flux loads from the inner bore surface while maintaining electrically non-conducting surfaces. Surface coatings that equal or exceed the heat transfer characteristics of the substrate of the arc heater segments and that are electrically non-conductive are needed. The use of smooth ultrahard thin films without any intermediate bonding material offers the potential to meet these needs. Mechanical loading of the segments (compressive stress) and thermally induced movement require any coating to be compliant with the copper substrate. The extremely high arc temperature (above 15,000K) and high pressure air (200 atmospheres) combine to form a highly oxidizing environment. Conventional thin film application methods result in a rough surface that is subject to high temperature oxidation and is a source of microcracks that weaken the coating. A coating surface that is smooth on the nanometer level will be resistant to oxidation and have a reduced number of microcracks making it less susceptible to brittle fracture.

Phase I: Phase I should demonstrate a technique to produce smooth (on a nanometer level) ultrahard coatings

on conventionally machined OFHC and optimize the coating parameters.

Phase II: Phase II should result in a prototype system for use in producing smooth (on the order of nanometers) ultrahard coatings on arc heater segments fabricated from OFHC and on other metallic substrates.

Dual Use Commercialization Potential: This project has commercial applications in high speed optoelectronic switches for computers and communication, optical and electronic sensors, optical windows, optics used in lasers, moving mechanical devices (bearings and linear actuator devices), analytical instrumentation, and improved resolution of optics for eyeglasses.

AF94-003TITLE:Non-Intrusive Measurements of Inlet Airflow Parameters For Ground Testing of Turbine Aircraft Engines

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop techniques to measure inlet flows during ground testing of turbine aircraft engines.

DESCRIPTION: This is a synopsis of the actual description. Submitters need to respond to the actual description which can be found in the technical information package available from the DTIC for this topic number. (See section on scientific and technical information in the DoD program description elsewhere in this booklet.) Should there be a difference in interpretation between this synopsis and the actual description, the latter will govern. In the ground testing required in the development of both military and commercial turbine engines there is a need to measure essential parameters of the airflow distributions entering engines at the compressor face in ways that do not disturb these flows. The flows are atmospheric air. There is to be no flow "seeding" of any kind: No addition of gas, liquid, or solid in even minute amounts. The measurements are to be made through the sides of a circular duct delivering air to the compressor face of an engine under test. The measurement apparatus is to be non-intrusive: there can be no material protrusion into the ducts in which measurements are to be made. Any transparent material used in the wall of the duct must maintain the smooth circular interior surface of the duct. Individual proposals are to be submitted to address the individual sub-topics (specify subtopic by letter) except if it is a selling point that one instrument system can address more than one of the following subtopics. a. Structure of the time-averaged velocity of the inlet distorted flow field at the compressor entrance face is required to meet vital aero-mechanical needs. b. Measurement of rapidly fluctuating velocity components in the inlet flow at the compressor entrance face is required for engine operational stability testing. c. Airflow density distribution at the compressor entrance face is required for performance determination. d. Airflow static-temperature distribution at the compressor entrance face is required for performance determination. e. Mass flow in the boundary layer of the duct. The entrance to the duct is bell shaped and near. The mass flow in the duct boundary layer, which is typically transitioning, is needed. Only this measurement could gain optical access from upstream of the duct entrance.

Phase I: Phase I should perform the analysis required for instrument development and demonstrate the principle of operation in a subscale laboratory environment.

Phase II: Phase II should produce a prototype instrument capable of operating for at least 8 hours and up to 30 hours without personnel attendance.

Dual Use Commercialization Potential: This project will have use in ground test facilities involved in commercial and military turbine aircraft engine development.

AF94-004TITLE:Room Temperature Infrared Focal Plane Array Imaging Radiometer

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop an instrument that operates at room temperature and makes high resolution imaging measurements in the infrared (IR).

DESCRIPTION: Current IR focal plane arrays (detectors) require cooling to cryogenic temperatures to function properly. AEDC has a need for an imaging radiometer (camera) based upon a room temperature focal plane array (FPA) that will operate in the 2 - 15 micron spectral range. The FPA should have at least 256 X 256 pixels with a high degree of uniformity and sensitivity adequate to be used at video rates and provide discrimination of 0.1 degree C at room temperature. The system should operate in hostile environments; the FPA should be insensitive to high noise levels and vibrations as might be experienced in harsh test cell applications.

Phase I: Phase I should provide the concept and demonstrate the availability of an appropriate FPA (detector).

Phase II: Phase II should result in a prototype system for use in AEDC test cell applications.

Dual Use Commercialization Potential: This project has commercial applications in all instrumentation which make IR radiation measurements (thermal imaging, spectrometers, radiometers, intrusion alarm systems, etc.).

AF94-005TITLE:Fast Response Balance

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a balance system with a fast response (high natural frequency) and a high sensitivity (low natural frequency).

DESCRIPTION: A new area of fluid dynamic phenomenon needing investigation is non-steady-state flight. This requires the ability to make measurements of small high-frequency or transient loads. Re-entry vehicles using pulsed jets for control, fighter aircraft wanting enhanced point and shoot capability, and vehicles maneuvering in space near other vehicles need fast response balance measurements for their operating systems. Such measurements require a balance system with a fast response (high natural frequency) and a high sensitivity (low natural frequency). A traditional strain gage balance can not be made sensitive enough to measure small loads of less than a pound-force (lbf) accurate to within 5% and also have a natural frequency of 100 hertz (Hz). This project will develop a three component (normal force, pitching moment, and axial force) fast response balance that has a 0 to 10 lbf load range accurate to within 5% and a natural frequency range of 10 to 100 Hz. The balance must also be less than two inches in diameter, less than six inches long, and support at least 200 lbf of normal force.

Phase I: Phase I should develop the concept for the fast response balance and demonstrate at least two (normal and pitching) components of the balance in a laboratory environment.

Phase II: Phase II should provide a prototype six degrees of freedom component fast response balance for use in AEDC test cells.

Dual Use Commercialization Potential: This project has commercial use in applications requiring vibration monitoring. It will be valuable for vibrational analysis of rotating machinery.

AF94-006TITLE:Long Taper Hone

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Industrial Production

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a device that can hone bores with a taper over lengths up to 100 feet.

DESCRIPTION: A device is needed that can efficiently hone bore diameters of between 2.50 inches to 3.50 inches with a taper ranging from 0.30 - 0.100 inches over bore lengths up to 100 feet. Small discrete steps are permissible but not desirable. The device should have the capability to either continuously monitor the bore diameter or measure it upon command without lengthy interruption of the honing. The device should be compact and be easily removable so that it does not interfere with normal operations. It should provide substantial savings in time over the current method in use; e.g., 40 hours for a honing taper of 0.045 inches.

Phase I: Phase I should develop the concept for the hone and demonstrate the concept on a 10 foot length of steel tubing with a bore of at least 2.5 inches.

Phase II: Phase II should result in a fully functional device for use at AEDC.

Dual Use Commercialization Potential: This honing device will have commercial application in the precision machining of short and long tubular products.

AF94-007TITLE:User-friendly Microcomputer Interface with Optimization Languages

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop an interface between microcomputer software and powerful optimization languages

DESCRIPTION: Mathematical optimization has been increasingly used since the late 1940's to improve the efficiency of large-scale logistic operations. Now the microcomputer and user friendly software are beginning to bring this tool to the individual user in the field, which has tremendous implications for improved efficiency at all levels. Although initial implementations of mathematical optimization in the spreadsheet environment have found widespread use, they are limited by deficiencies of this environment: inability to scale smoothly with data, inability to expand in dimension, and difficulty of model documentation. Existing modeling languages that overcome these deficiencies such as GAMS, AMPL, and LINGO are too cumbersome for typical users. The introduction of a new class of multidimensional spreadsheet by two major software firms, Improve from Lotus Development Corp. and Compete from Computer Associates, appears to overcome these drawbacks and enable the development of software that is both mathematically powerful and usable by people who are not technically trained.

Phase I: The project will develop software to translate a model in Improve or other comparable software into one or more of the mathematical modeling languages cited above and to return the results of the optimized model to the underlying modeling language.

Phase II: Improve or other comparable software will be extended to be functionally equivalent to one or more of the languages above. Alternatively, new software combining the properties of a
multidimensional spreadsheet and a special purpose language for the specification of mathematical programs can be developed. The resulting software should contain additional modeling capabilities such as the automatic generation of statements involving logical variables and the ability to develop network models through the manipulation of graphical objects.

Phase III: Optimization software will be bundled with advanced spreadsheets and commercialized as is the case today with Excel and Lotus optimization "solvers".

Dual Use Commercialization Potential: As conceived, the end product will be a powerful analytical tool with wide applicability in the commercial and military markets.

AF94-008TITLE:Low-Cost Robotics Research Platform

CATEGORY: Basic Research

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop low-cost anthropomorphic robotics research and development tool

DESCRIPTION: Agile, anthropomorphic robots have many potential applications in the military and commercial sectors. Application examples include: automated supply operations, aircraft bomb loading, industrial operations in environments hostile to humans, precise surgical intervention, and support of quadriplegic. Robotics research is generally regarded as costly in terms of money, time, and experience. Thus many research and development teams are deterred from performing much need work in this key area. The intent of this project is to build a general purpose robotics research device which can be easily interfaced to existing workstations and microcomputers. Of particular interest is a complete system with a simple interface and real-time command shell that can be remanufactured at low cost for use in multiple university research projects. Each component should be developed in a way that guarantees the greatest flexibility with future modifications. The effort would include development of the device, interfacing, and the development of a sample controller.

Phase I: Identify the design of the total system. Prototype the interface, software, and a single physical subsystem. Demonstrate closed-loop control of that subsystem.

Phase II: Develop the complete anthropomorphic system. Quantify the system's utility by demonstrating, installing, and evaluating use at government, industrial, and university sites.

Phase III: Finalize the system using lessons learned from the Phase II research; manufacture and market the final product.

Dual Use Commercialization Potential: The general-purpose robotics device will provide universities, industrial firms, and government organizations with an affordable research and development tool.

AF94-009TITLE:Remote Atmospheric Sensor System

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop improved systems or techniques for remotely sensing the atmospheric environment.

DESCRIPTION: The Air Force is interested in advanced techniques for surface-, airborne-, and/or satellite-based remote sensing of the troposphere and stratosphere. It is particularly interested in more accurately determining the vertical profiles of temperature, pressure, winds, water vapor, and aerosols at higher spatial and temporal resolutions. Current operational systems are inadequate to support the expected mesoscale numerical weather prediction models of the future. Rawinsondes are too infrequent and too far apart
geographically, and satellite soundings are too inaccurate. New methods will be needed to support battlefield and relief operation forecasts anywhere in the world, even where conventional weather observations may not be available.

Phase I: Conceptualize and design new system/techniques for the remote sensing of the atmosphere.

Phase II: Build a prototype system and then perform laboratory or field experiments to test the Phase I design.

Phase III: Refine the new system and then market it to government agencies and the commercial sector for deployment aboard weather satellite or ground-based platforms.

Dual Use Commercialization Potential: Many government and commercial operations are dependent upon an

accurate knowledge of atmospheric conditions. Commercial aviation strives for increased fuel economy and passenger comfort through computer-generated flight plans that factor in weather conditions. Governments are interested in issuing accurate severe weather warnings and improved atmospheric pollution monitoring. Agricultural application of herbicides and insecticides is highly dependent on accurate weather forecasts. World-wide markets exist for the instrumentation and techniques resulting from this research effort.

AF94-010TITLE:Opto-Electronic Components from Non-Stoichiometric III-V Materials

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Explore applications of highly non-stoichiometric GaAs and related materials for opto-electronic components, devices and subsystems.

DESCRIPTION: It has been shown that GaAs grown via molecular beam epitaxy (MBE) at unusually low growth temperatures has unusual and potentially useful structural, electronic, and optical properties. The unusual properties include an excess of arsenic, high resistivity, high dielectric breakdown fields and very fast photo-induced carrier recombination times. This growth approach has been applied with varying success to other III-V binary and ternary compounds. Opto-electronic demonstrations include ultrafast photocunductive switches and optical waveguide structures. This project seeks new, promising concepts in which these materials are used in
opto-electronic structures and devices. Applications include, but are not limited, to the examples given above. The monolithic integration of electronic and opto-electronic functionalities is encouraged.

Phase I: The feasibility of the concept should be demonstrated through modeling and/or processing and fabrication.

Phase II: The concept should be carried to the point of demonstrating military/commercial potential and producibility.

Phase III: Develop the controlled manufacturing process procedures, including repeatable growth techniques and reliable fabrication techniques including delineated growth or isotropic etch of arbitrary patterns. Specific devices should result that are manufacturable at competitive cost for marketable applications.

Dual Use Commercialization Potential: The end product should have great potential to serve as a key component in communication and sensing systems with applications in the military and commercial sectors of the market place.

AF94-011TITLE: Compact Light Sources Based on Non-Linear Optics

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop efficient, compact, moderate power, coherent, visible or infrared light sources using nonlinear optical techniques.

DESCRIPTION: Many important uses exist for compact, efficient, coherent light sources. Such energy sources have, for example, applications in high density data storage and in large area display devices. A variety of promising demonstrations have shown that nonlinear techniques such as second harmonic generation, sum frequency generation, and up conversion of existing laser sources are capable of providing such sources. This program seeks to demonstrate

all of the elements required to make practical, economical sources, using these or any other nonlinear optical techniques.

Phase I: Develop detailed designs and show feasibility of critical concepts.

Phase II: Develop and demonstrate complete prototype light source, and demonstrate it meets goals and specifications originally targeted.

Phase III: Modify prototypes, as necessary, and develop volume manufacturing plans, capabilities, and facilities, and appropriate marketing plans to OEMs and end users.

Dual Use Commercialization Potential: The end product would serve as a key component in data storage devices and in large area displays, both of which are used throughout the civilian economy and in defense applications.

AF94-012TITLE:Detectors for Hidden Chemical Corrosion

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Development of depot-level instrumentation to indicate chemical corrosion at the nanometer scale.

DESCRIPTION: Because less money is available for new aircraft in post-Cold War budgets, aircraft in the current Air Force inventory will remain in service longer. The commercial airlines are also curtailing the purchase of new aircraft, effectively resulting in aging commercial fleets. In each case the aircraft maintenance community is challenged to ensure the aging aircraft have the requisite structural integrity to meet the stresses imposed by operational conditions. Current logistics efforts by both the Air Force and the Federal Airline Administration (FAA) aim at developing instruments to perform nondestructive evaluation (NDE) of hidden corrosion and material degradation with high degrees of accuracy, sensitivity, and versatility. Understanding the fundamental chemistry of corrosion is essential for designing future instruments for aircraft depot maintenance, along with future aircraft design and construction methods. Research proposals must address the effects of surface chemistry, the atmosphere, and major atmospheric pollutants on the initiation of the corrosion process. Experimental studies of corrosion initiation at the nanometer scale must be correlated with chemical kinetics and macroscopic structural damage parameters of component lifetimes to meet the overall goals of this program. Proposals are sought which address both Air Force and FAA needs.

Phase I: Develop and implement a research effort which better identifies surface regions where corrosion is most likely to occur.

Phase II: Develop improved methods for early corrosion detection and identification of better methods and processes to use for surface modification to prevent corrosion. Develop, test, and refine corrosion detection instruments and associated techniques.

Phase III: Final development, manufacturing, and marketing of an instrument and associated techniques which are capable of detecting the initiation of hidden corrosion in aircraft.

Dual Use Commercialization Potential: The end products of this research would be used by both the Air Force and commercial airlines for early detection of hidden corrosion in aircraft and aircraft components.

AF94-013TITLE:Embedded Heat Transfer Sensors for Turbomachinery

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative high temperature heat transfer sensors and arrays for turbomachinery applications.

DESCRIPTION: Unsteady flow phenomena play a central role in gas turbine heat transfer processes. Measurement of unsteady heat flux in turbomachinery is essential to fully understand the basic physics of turbomachinery heat transfer processes. Present sensors are limited in frequency response, spatial area coverage, and range of sensing temperatures. Improved, high temperature microsensors for heat transfer measurements in turbomachinery flows are needed to provide greater area coverage, higher frequency response, and better reliability and affordability than present sensors. This announcement seeks innovative ideas leading to surface heat transfer rate measurement capability at temperatures to 600 degrees Celsius, with sensor arrays providing spatial coverage in the range of 1 to 20 square centimeters, with spatial resolution on the order of 0.1 mm and frequency response to as much as 50 kHz. Ideally, sensor arrays would be embedded, rugged, self calibrating, and self testing.

Phase I: Develop the heat transfer sensor concept. Identify the sensor's critical components and functions. Demonstrate the concept's feasibility by theoretical, computational, or experimental means.

Phase II: Design, fabricate, and test a prototype embedded sensor with performance characteristics approaching those described above.

Phase III: Develop and market operational heat transfer sensor arrays for research, development and control applications in high temperature environments such as gas turbine engines.

Dual Use Commercialization Potential: The end product will have direct applicability to turbomachinery (e.g., jet engines and electric power plant gas turbines) used in both the military and commercial market.

AF94-014TITLE:Human Systems/Subsystems Research

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance human performance as an integral part of Air Force systems and operations. Five directorates perform a full spectrum of basic and applied research including exploratory and advanced development: (Specify subtopic by letter).

a. The Human Resources Directorate conducts research in manpower and force management, training systems, and logistics technologies. The objective is to improve the operational readiness and effectiveness by developing technologies enabling more effective training, selection, assignment, and retention of personnel.

b. The Crew Systems Directorate conducts research to assure optimal man-machine integration. Goals include understanding the limitations of humans to mechanical stresses (noise, vibration, acceleration, and impact), providing design criteria for weapon system development/enhancement, proposing protection devices, and improving human/weapon system interface.

c. The Aerospace Medicine Directorate addresses the medical selection, protection and enhancement of humans in Air Force systems and operations. Mission-related research and specialized operational support are conducted in aeromedical consultation, epidemiology, drug testing, and hyperbaric medicine. Clinical sciences research is conducted to develop standards for aviator selection and retention.

d. The Occupational and Environmental Health Directorate assesses risks to personnel from hazardous materials, noise, electromagnetic radiation, and occupational processes and conducts research to reduce those risks. The goal is to mitigate impacts on health and to enhance the scientific understanding of the underlying biological mechanisms.

e. The Environics Directorate conducts research on the environmental behavior, transport, and ultimate fate of chemicals in air, soil, or water; advanced containment characterization and pollutant monitoring technology; destruction of pollutants including biodegradation as well as physical chemical means; contamination cleanup technologies; hazardous waste minimization for processes of significance to the Air Force and new and innovative concepts to eliminate, substantially reduce, or mitigate environmental consequences of Air Force operations.

AF94-015TITLE:Chemical and Biological Warfare Defense Detection and Decontamination Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Chemical and Biological Systems

OBJECTIVE: Develop sensors to detect and identify chemical/biological agents and methodology for biological decontamination.

DESCRIPTION: This requirement is for novel methods to detect and identify highly toxic chemicals and pathogens and technology to decontaminate pathogens. (Specify subtopic by letter)

a. A need exists for a continuous monitor to rapidly identify and warn of the presence of chemical agents in either liquid or vapor phase.

Phase I: Phase I will result in the design and fabrication of a laboratory prototype system which shall demonstrate the proof of principle and detect and identify nerve and blister agents in either a vapor or liquid phase.

Phase II: The Phase II will optimize the detector system, laboratory and field test it against stimulants and at least two agents, and fabricate a breadboard for testing at a designated facility.

Dual Use Commercialization Potential: This technology can be adapted to address the concerns of the environment by including the ability to detect industrially produced hazardous materials and other environmental pollutants. Technology may be applied to on-site monitoring of hazardous materials at industrial or hazardous waste sites or random-site monitoring of environmental pollutants at any location.

b. There is a need to produce a biological warfare detector. An ancillary need is to rapidly ascertain viability and virulence of nonmotile microbes. In order to integrate into currently developing biosensor programs, technology should be based on physical parameters such as optical or electronic assessment of unaltered or tagged microbial samples. Other nonphysics-based technologies for assessment of viability/virulence will also be considered.

Phase I: Phase I will result in design and fabrication of a laboratory prototype system which shall illustrate efficient and rapid evaluation of viability and/or virulence of technology.

Phase II: Phase II will result in production of a prototype device and more in-depth evaluation of the device characteristics.

Dual Use Commercialization Potential: This technology will be useful in environmental protection, clinical diagnostic, and therapeutic areas. Technology can be used for a blood clinical diagnostic system or as a hospital operating room monitor.

c. This requirement is to develop a simple and facile method to rid aircraft interiors and other equipment (which is difficult to decontaminate), of biological threat agents. The optimal technique will involve an inexpensive material and/or device, that will be highly mobile, effective against a wide variety of biological threats, non-toxic to personnel, and rapid, and will not degrade aircraft interior materials.

Phase I: Phase I will result in design and fabrication of a laboratory prototype system which shall demonstrate the proof of principle and a demonstration on a wide range of microbes, viruses, and/or biotoxins.

Phase II: Phase II will require an in-depth analysis of the technology in a real aircraft and large-scale production of reagents or related analogs with different properties or production of a prototype device for biological decontamination.

Dual Use Commercialization Potential: The technology developed applies to the environmental protection, clinical diagnostic, and therapeutic areas. Technology may be applied for on-site contamination control of industrial contaminants.

AF94-016TITLE:Human Health Standards for Groundwater Contaminants

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Provide scientifically defensible drinking waterstandards for selected organic contaminants found in

groundwater.

DESCRIPTION: This requirement is for developing weight of evidence criteria for classification of chemicals as carcinogens, and developing mechanistic data for dose-response modeling to extrapolate rodent experimental findings to humans. Billions of dollars are spent on environmental clean-up of landfills using US EPA derived approaches for assessing health risks. These methods for risk assessment are not defensible based on science. This research effort will provide scientifically based approaches for assessing the human health risks for five common organic contaminants found on Air Force bases.

Phase I: Phase I will result in a documented indepth evaluation of the weight-of-evidence methods used by the US EPA and others (countries, states, industry, etc.) for five organic chemicals and will include detailed state-of-the-art technical approaches to develop
scientifically defensible health assessments for the five organic chemicals. Such approaches could include epidemiologic evaluations, statistical analyses, pharmacokinetics and pharmacodynamic laboratory experiments and pathologic examinations.

Phase II: Phase II activities may include: identifying chemical specific mechanisms of action that can be used in dose-response modeling of the five organic chemicals, demonstrating the use of mechanistic data in dose-response modeling, incorporating weight of evidence in quantitative risk analyses, and conducting collaborative research between the Toxicology Division and the awardee and use of biomarkers.

Dual Use Commercialization Potential: Phase III may result in the commercialization of risk assessment software, mathematical techniques for assessing health risks or laboratory methods to establish target organ dose response biomarkers for use in risk assessment.

AF94-017TITLE:Electromagnetic Radiation Effects and Measurement Devices

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Develop human body exposure/response algorithms and monitor interfaces associated with electromagnetic radiation.

DESCRIPTION: This requirement is for the development of numerical algorithms which can calculate the response of the human body to ultrashort microwave and laser pulses. The modern occupational environment is such that a worker may encounter novel electromagnetic fields produced by either microwave or laser devices. The safety of these electromagnetic fields is determined, at least in part, by the amount of energy deposited into living tissues by these fields. When the environmental fields are constituted by continuous wave radiation, the amount of energy entering various living tissues and organs can be estimated using numerical algorithms that run smoothly on modern digital computers. However, when the environmental fields are pulsing in nature, the calculations become much more difficult because of the dispersive nature of human tissue. Dispersion means that each frequency component in the pulsing field is treated differently by the living tissue.

Phase I: Phase I will result in numerical algorithms that properly calculate ultrashort pulse propagation in strongly dispersive, irregularly shaped objects such as the tissues and organs of the human body.

Phase II: The Phase II effort will result in software algorithms for use by safety, health, and regulatory agencies. Our interest is with environmental fields penetrating the human body and doing potential damage there. However, our interest also resides in using low-level electromagnetic fields to image the human body to search for disease and analogously to visualize wastes buried or seeping in soils.

Dual Use Commercialization Potential: Phase III potential is for numerical algorithms for detection technologies and for imaging technologies for the purposes indicated.

AF94-018TITLE:Improved Assessment of Vestibular System Function

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop innovative concepts, models, and diagnostic tools for evaluation of vestibular system performance.

DESCRIPTION: A properly functioning vestibular system is critical in dealing with the multisensory environment of flight. Standard clinical tests of vestibular function may not always detect operationally significant levels of vestibular dysfunction. Producing improved vestibular tests may result by upgrading existing tests or by devising new ones. Existing tests could benefit from improved stimulus delivery systems, advanced data collection methodology, innovative data analysis, and improved interpretation. New tests could incorporate novel stimulus modalities and/or response measurement technologies. Other improvements could include development of mathematical models of vestibular function, or other conceptual frameworks, to aid in test data interpretation.

Phase I: Phase I will identify, rationalize, and evaluate an approach to the improved assessment of vestibular function. This approach may consist of a completely new testing concept, a significant enhancement of a standard testing concept, or a significant component for such a testing system.

Phase II: Phase II will develop the concept to the prototype stage, producing a working model of the vestibular testing system and demonstrate the efficacy of the concept.

Dual Use Commercialization Potential: An improved system for testing vestibular function will be of interest to Otologists, Otolaryngologists, and Neurologists. The currently available commercial testing devices lack the sensitivity and specificity required for the accurate diagnosis of vestibular dysfunction. Once validated, a significantly improved testing system could successfully compete in the commercial marketplace.

AF94-019TITLE:Cardiac Output/Stroke Volume Pulsed Doppler Flowmeter (FM)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop a pulse-Doppler volumetric flowmeter to determine beat-to-beat cardiac output in the ascending aorta.

DESCRIPTION: Develop a blood volumetric flowmeter that is much more accurate than commercially available pulse Doppler or electromagnetic flowmeters and is suitable for use on the ascending aorta and/or pulmonary artery. The flowmeter must output beat-to-beat estimates of cardiac output and stroke volume data, and instantaneous vessel diameter, in addition to the normal Doppler flowmeter outputs of range, phasic and mean velocity, and direction-detected Doppler shift auditory output. The flowmeter system will use pulse Doppler crystals attached at known angles to the compliant vessel wall and will calculate the instantaneous velocity profile within the vessel and the instantaneous diameter many times during pulsatile flow. From the flow velocity profile and the vessel diameter, the volumetric flow can be estimated. The Doppler transducer will be chronically implantable and measure velocity and diameter simultaneously. The probe must not significantly alter the local vessel compliance. The Doppler signal conditioner should minimally appropriately excite 5 and/or 10 Mega Hertz (MHz) piezoelectric crystals with a fixed sine wave (5 or 10 MHz, respectively). Fixed Doppler excitation frequencies of 5 and 10 MHz are of primary importance. Future applications may necessitate use of 20 MHz excitation frequencies. Frequency modulated (chipped) crystal excitation should also be considered. FM excitation frequencies would be centered on the fixed frequencies with a worst-case bandwidth of +/- 10 MHz and a probable bandwidth of +/- 5 MHz. The system should be designed to function with a vessel diameter range of 2 to 28 mm. State- of-the-art analog techniques to maximize the signal-to-noise ratio and provide an enhanced Doppler-shift demodulation/phase detector should be implemented, where possible. Advanced real- time frequency and time domain analysis techniques should be considered.

Phase I: Phase I will be a survey and analysis of current technology and identification of potential.

Phase II: One or more of the most promising will be developed to the prototype lead; and test and evaluation

will be conducted, especially on engineering aspects.

Dual Use Commercialization Potential: Commercial applications include feedback control for pulsatile cardiac assist and by-pass pumps, and post-surgical evaluation of cardiac or vessel replacement procedures.

AF94-020TITLE:Coronary Catheter-based pH Probe

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a pH coronary catheter capable of measuring beat-to-beat changes in local bold pH.

DESCRIPTION: Develop a pH meter and catheter system that is usable in small coronary arteries for extended periods of time. The device should accurately and safely measure local coronary bold pH for periods to exceed 4 hours. It should have a time constant that is short enough to accurately determine beat-to-beat blood pH. The pH catheter should be sized and designed to allow for placement in the coronary arteries via standard cardiac catheterization approaches. The catheter must be capable of considered "disposable." It must be easily calibrated in a sterile environment. Temperature stability or compensation is also a major design criterion. Solid state or fiber optic pH transducer technology is suggested.

Phase I: Phase I will review the state of the technology and analyze possible approaches/designs, critique them, and propose an approach.

Phase II: Phase II will develop one or more prototypes of the best potential design, conduct preliminary tests and evaluation, particularly on engineering aspects, and submit the prototypes and specifications.

Dual Use Commercialization Potential: Applications include coronary artery disease state and angioplasty effectiveness.

AF94-021TITLE:Emission Control for Particulate Air Toxic Substances

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Demonstrate technical and economic feasibility of novel particulate air toxic emissions control for industrial operations.

DESCRIPTION: In Title 3 of the Clean Air Act Amendments, the list of 109 air toxic substances subject to emission standards includes a number of involatile substances that are likely to be emitted only as dusts or suspensions in air. Because Title 3 enforcement is only beginning, the experience base in technologies for compliance with these requirements and at the lower levels to be expected is minimal. Recirculation or discharge of air from processes as metal finishing, abrasive depainting, or spray painting, etc. requires treatment to lower the amounts of air toxic substances to less than the applicable industrial hygiene or air quality standard. Technologies investigated may be process-specific or general; they may include one or more air toxic particulate substances; and they may include or exclude volatile air toxic substances. The concept as presented may be a complete treatment technology, or it may augment a separate treatment method.

Phase I: Phase I effort should result in experimentally generated data indicating whether or not the technology will be useful as a treatment method. Furthermore, it should identify processes or air toxic substances for which the technique is applicable and it should accomplish a preliminary economic analysis of the technology compared to

existing treatment methods.

Phase II: The Phase II effort will establish the economic and technical feasibility of the technology when used to control air toxic particulate contamination locally in or around one or more AF industrial operation(s). The Phase II will also produce all information needed to implement the technology.

Dual Use Commercialization Potential: This requirement is common to many DOD and commercial industrial operations.

AF94-022TITLE:Treatment of Firefighter Training Facility Process Water and Wastewater

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Method for treating aqueous firefighting foam,hydrocarbons, and their byproducts in firefighter training facility
water.

DESCRIPTION: Innovative methods are needed for treating process water and wastewater prior to recycling or discharge. Water at firefighter training facilities becomes contaminated with hydrocarbons (including benzene, toluene, ethylbenzene and xylene), partially burned hydrocarbons, aqueous firefighting foam, degradation byproducts and dust/dirt. When released to a sewage treatment plant on receiving waters, Aqueous Firefighter Foam contaminated water can kill aquatic life as well as producing a highly visible foam. Evidence suggests the aqueous firefighting foam, as in accidental discharges and real world use, is also of interest and is considered a secondary objective.

Phase I: In Phase I, a promising technology for treatment of process and wastewater will be tested in the laboratory at bench scale. Results of the bench scale tests will provide the basis for estimating economics of the treatment method.

Phase II: In Phase II, a prototype system will be designed, built, and tested. Following testing at the contractor's facilities, it is anticipated that the unit will be demonstrated at two Air Force Firefighter Training Facilities-one designed for LPG fuel with total water recycle and one typical of those using jet fuel.

Dual Use Commercialization Potential: The technology will be applicable to both military and civilian firefighter training facilities. There is also potential for application to Aqueous Firefighting Foam and degradation byproducts encountered during remediation of firefighter training facilities.

AF94-023TITLE:Characterizing Bacteria Using Arbitrarily Primed Polymerase Chain Reaction (AP-PCR) Techniques

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an innovative method for determining bacterial degradative capabilities using AP-PCR techniques.

DESCRIPTION: Recently Investigators have begun using arbitrarily primed polymerase chain reaction (AP-PCF) techniques in order to generate strain specific amplification patterns from bacterial Deoxyribonucleic Acids (DNA). The technique is powerful because it is rapid, repeatable, relatively simple, and allows differentiation of bacterial isolates at the sub-species level. The Polymerase Chain Reaction is used to generate a pattern of amplicons from purified bacterial DNA and a random oligomer primer. The pattern is dependent upon the distribution of annealing sites for the primer within the bacterial genome. The pattern is readily established by agarose gel electrophoresis, and it is different for even closely related species of bacteria. It can be used as a means of identifying environmental or

clinical isolates in much the same way as human fingerprints are used in forensic science. The limitation of the technology also parallels that of forensics; the establishment of a data base is critical to the broad use of the technology. The initial development of the technology requires the establishment of AP-PCR patterns for a large number of bacterial strains which can subsequently be used to identify unknown microbial isolates.

Phase I: Phase I work should address the collection of strains, the classification of those strains (if not already established) by well-established methods, and the compilation of AP-PCR data. Priority in establishment of the data base should be given to those organisms with known or suspected biodegradative capabilities. Proposers must have demonstrated competence in microbial systematics and propose innovative methods for the coding, storage, and retrieval of AP-PCR pattern data. Once this data base is compiled, bacteria isolated from contaminated sites on non-selective culture media or by selective enrichment on specific carbon sources could be rapidly fingerprinted and identified in order to predict the degradative capability in-situ. Such information would be valuable in determining the remediation processes to be used at a given site.

Phase II: Phase II will involve the direct isolation of nucleic acids from groundwater sediment samples in order to assay for the presence of bacteria without the use of culture techniques. The establishment of methods for the production of community-based patterns or individual patterns from next DNAs should be considered only after establishment of the data base the pattern comparison protocols.

Dual Use Commercialization Potential: This technology is common to many DOD and commercial industrial operations

AF94-024TITLE:Dense Nonaqueous Phase Liquid Aquifer Remediation

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a treatment process to decontaminate aquifers containing Dense NonAqueous Phase Liquids (DNAPLs)

DESCRIPTION: Hazardous waste sites contaminated with DNAPLs (usually chlorinated solvents) present special problems to remediation activities. The dense organics sink to the bottom of the aquifer to form pools or disassociated droplets (ganglia) of pure phase product. This pure phase then slowly leaches into the surrounding aquifer, providing a long-term source of contamination.

Phase I: Phase I is the development and proof of concept of a treatment system to remediate a 10-cubic-foot test cell contaminated with trichloroethylene. It will also provide scale-up and operating parameters for a Phase II effort. Restoration verification of the test cell will include soil analysis down to the parts per million level and water analysis down to the parts per billion level.

Phase II: Phase II will be the operation of the treatment system at a contaminated Air Force approved site. Bioremediation and "pump-and-treat" technologies are outside the scope of this topic.

Dual Use Commercialization Potential: Full-scale development and commercialization of the treatment system.

AF94-025TITLE:Biological Methods for Complete Destruction of Nitro- Substituted Contaminants

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop innovative biological methods for the degradation of nitro-substituted compounds in contaminated soil or water.

DESCRIPTION: Knowledge surrounding the biodegradation of nitrogenous contaminants such as energetics, missile fuels, and nitroaromatic solvents, and explosives is limited. Early research led to the conclusion that nitro compounds either resist biodegradation or are reduced to amines which are more toxic than the parent compounds. Novel oxidation reactions may completely detoxify nitrogenous contaminants. These discoveries suggest that biological treatment will be effective for degrading nitrogenous compounds. Current technologies include composting and incineration. The composting process produces unknown, potentially toxic, intermediates, and incineration is an extremely expensive treatment option. There is an ongoing need to understand the biochemical mechanisms and to develop new biological processes for complete destruction of these compounds.

Phase I: Phase I will identify novel processes for the complete biodegradation of nitro-substituted contaminants including nitrobenzenes, nitrotoluenes, RDX, HMD, and TNT that could lead to the development of a biotreatment system for contaminated soil or waste streams.

Phase II: This effort will implement the development and testing of such a system using contaminated material.

Dual Use Commercialization Potential: Full-scale development and commercialization of a in-situ or ex-situ bioreactor system

AF94-026TITLE:Landfill Remediation Techniques

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a chemical/physical treatment process to remediate landfills containing hazardous chemicals

DESCRIPTION: Past operation of landfills allowed the discharge of what are now considered hazardous materials. These may have been released in dumped waste liquid form or from leaking drums filled with toxic liquids. Leachate from landfills could contaminate large areas downstream from the site. The technology sought would remove, neutralize and/or destroy the source of the contamination, not just collect the leachate and treat it. In this manner, long-term source reduction of toxic threats to the environment is achievable.

Phase I: Phase I should cover the development and proof of concept of a treatment system to remediate a 10-cubic-foot test cell representative of a typical landfill. Phase I should also provide scale-up and operating parameters for a Phase II effort. The measure of merit will be the amount of contamination removed, destroyed, or neutralized.

Phase II: Phase II will be the operation of the treatment system at a contaminated Air Force selected landfill site.

Dual Use Commercialization Potential: Full-scale development and commercialization of the treatment system

AF94-027TITLE:Concentrated Oxygen and Storage Technologies

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop innovative state-of-the-art, light-weight, compact, and self-contained oxygen separator and storage technologies.

DESCRIPTION: A need exists to generate and store significant quantities of oxygen on-board aircraft to support multi-man aircrews. In addition, significant quantities of oxygen are needed for patient care during all phases of the aeromedical evacuation mission. Current technology is limited in the amount and quality of oxygen that can be generated and stored while in flight on-board aircraft. This effort seeks to initiate innovative state-of-the-art oxygen generation and storage technologies to produce systems capable of generating and storing oxygen to support many individuals while in flight. Emphasis should be place on increasing oxygen recovery rates, maximizing oxygen concentration, minimizing weight, minimizing size, and reducing power consumption. Major innovative technologies would include: oxygen concentrator, oxygen storage, oxygen delivery, and associated controls.

Phase I: The Phase I effort will involve a preliminary engineering design.

Phase II: The Phase II effort would involve the detailed design, construction, and testing of the complete system.

Dual Use Commercialization Potential: The commercial spin-off technology would be applied to generate and store oxygen for medical, industrial, and commercial aerospace purposes. Medical applications include oxygen for respiratory therapy. Other applications in the industrial area include filling of oxygen bottles, biotechnology, environmental waste reduction, and chemical processes.

AF94-028TITLE:Human Sensory Feedback in Air Force Telerobotic Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop sensory feedback technology for intuitive human operation of robotic systems in hazardous environments.

DESCRIPTION: Concepts for human control of robots in hazardous unstructured Air Force environments combine the cognitive abilities of the human with the hardiness and heavy manipulation capabilities of robots. By capitalizing on human judgment and the robot's ability to operate in conditions lethal to humans, the advantages of each "system" can be exploited. Human operator awareness (feedback) of the robot's work environment adds significant flexibility to mission capability. The challenge is to develop quality feedback from the robot to the operator. Two specific current challenges are: (Specify subtopic by letter)

a. Force Feedback to Small Exoskeletons: Fine manipulation using human-sized robotic hands requires human-sized hand exoskeletons for intuitive control. Force Feedback to these small exoskeletons requires small-volume, high-efficiency, semi-linear actuator mechanisms. Actuators are needed to provide human range forces and velocities to exoskeletal systems used by operators of dexterous manipulators.

Phase I: Phase I could result in actuator technology demonstration prototypes.

Phase II: Phase II product could be miniaturized actuators on prototype hand exoskeleton.

Dual Use Commercialization Potential: Small-volume, high-efficiency, semi-linear actuators can be applied to many commercial products. These actuators could power miniature robots, servo mechanisms, human hand prosthetics, manipulation aids for handicapped people, etc. Any actuation technology that can meet the size, speed, and power requirements of the small exoskeletons, can be scaled upward to improve the design of a plethora of larger applications.

b. Force Feedback from Synthetic Environments: Current human interfaces to Virtual Reality and Synthetic

Environments consist of audio and visual feedback only. The next dimension to operator immersion in Synthetic Environments for training and simulation is to generate synthetic forces that represent the "feel" of the objects in the synthetic environment. Algorithms and methodologies must be developed which allow existing computer systems to fabricate realistic forces from graphical models in real time.

Phase I: Phase I could result in algorithms that synthesize interaction forces for geometry primitives.

Phase II: Phase II product could be a computer program that displays graphical simulations and computes interaction force vectors between simulated objects.

Dual Use Commercialization Potential: The algorithms used to model force interaction among synthetic objects in a synthetic environment will be directly applicable to training and entertainment industries. Once we can make a person feel the simulated objects that they can now see in virtual reality systems, the usefulness of simulation for training will increase by an order of magnitude. The algorithms will contribute to next-generation arcade games, virtual training systems for a host of industries, and will enhance computer-aided design (CAD) software packages by allowing CAD users to intuitively manipulate their designs without fabricating prototypes in hardware.

AF94-029TITLE:Crew Protection Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-Systems Interfaces

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Enhance crew protection systems in Air Force operational environments

DESCRIPTION: A requirement exists for effective voice communications, crew safety, and human performance in environments that are based on natural, intuitive interfaces using innovative abilities and requiring no learning or training for efficient operation. The intuitive interfaces facilitate operator task performance, reduce workload and fatigue, and improve personal safety. These intuitive interface technologies include but are not limited to: 1) auditory system modeling and neural network for robust signal processing of speech; 2) digital audio technology to allow integration into aircraft systems; 3) voice communications countermeasures/counter-countermeasures; 4) noise-induced hearing loss sound protection; 5) active noise reduction; and 6) 3-dimensional auditory display for spatial awareness and communications.

Phase I: Phase I efforts would provide an assessment of the state of the art and an approach to develop an appropriate intuitive interface technology.

Phase II: Phase II efforts would provide a demonstration and validation of the intuitive interface technology.

Dual Use Commercialization Potential: Commercial applications of these technologies are possible in the commercial aviation, entertainment, industrial safety, and health care fields.

AF94-030TITLE:Systems to Remove Electroencephalographic Artifacts and Develop Functional Brain Atlas

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop software to remove electroencephalographic artifacts and methods for development of cognitive function brain atlas. (Specify subtopic by letter)

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter).

a. This requirement is for the development of a software system which will correct/remove artifacts from ambulatory
psychophysiological data.

Phase I: Phase I will result in a plan to identify and correct physiological artifacts from psychophysiological data.

Phase II: Phase II will result in a software system, written in transportable code, that can be used to produce "clean" ambulatory data. The collection of ambulatory data from operators performing their daily tasks is becoming more common and the largest problem remaining is artifact contamination of the data. Ambulatory recording of physiological signals is used for monitoring the effects of workload, situational awareness, fatigue, and other factors. The main source of data artifacts is physiological in origin and is produced by movement, muscle artifacts, eye blinks, heart beats, etc. These "physiological" artifacts contaminate the signals of interest, brain waves, heart rate, eye blink, and respiration. On-line removal is required in systems that provide in-the-loop physiological data. By developing methods to detect and correct the physiological artifacts, it will be possible to create on-line systems for the monitoring of operator workload and state. The elimination of these artifacts will permit the widespread use of physiological data to monitor operator state and workload. Several off-line methods are available, but an on-line system for dealing with all types of physiological artifacts must be developed.

Dual Use Commercialization Potential: This software would be very useful in several commercial applications including clinical and research neurology and psychiatry and test and evaluation.

b. This requirement is for the development of analysis methods and the format for the development of a functional atlas of cognitive brain electrical activity. Multichannel brain wave data is currently being collected in a number of aircraft and simulators. New and validated methods are required for the analysis of the huge amount of data produced which permit meaningful interpretation with regard to cognitive brain function. However, very little laboratory data exists from controlled multi-task laboratory experiments. An analysis system is required that will permit the development of a database of brain activity in multitask situations so that the flight data can be properly interpreted. This includes research in the areas of human cognition and workload. A system is required which uses all aspects of the available brain wave data and permits the development of normative data. Methods must be developed which are mathematically valid and physiologically meaningful.

Phase I: Phase I will result in the development of a strategy for data analysis and database development.

Phase II: Phase II will result in a system for the analysis of brain topographic data and the beginning of a database for a functional brain atlas based on brain wave data.

Dual Use Commercialization Potential: Commercial applications would include psychiatry, neurology and basic cognitive research laboratories.

AF94-031TITLE:Case-Based Reasoning/Retrieval Technology for Design Groups

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop intelligent groupware for support of design teams distributed at remote, geographical sites.

DESCRIPTION: Design groups often involve the interaction of many participants which can vary in time, place, culture, knowledge, and ability. Frequently this requires an elaboration of design rationale, the uncovering of design histories, and the progressive deepening of knowledge. These design activities are highly contingent on design context, vary with individual team member perspectives, are highly dependent on situated memory, tend to undergo rapid shifts that are not linear in nature, and are subject to much disagreement when tradeoffs or other forms of decision making are transacted in group settings. Although design rationale may be useful for developing policy decisions, issue exploration, compromises, and tradeoffs, it typically only exists in a single member's mind and thus is not available for other member's use. When multiple perspectives are available to examine design problems from differing viewpoints, there is a basis to translate design requirements into workable design solutions. A case-based reasoning/retrieval product for design groups would provide a distributive design environment to afford team members the means to distribute ideas, engage in group-centered policy decisions, discuss issues, capture concepts and designs, and generate multimedia representations; all of which are important considerations for the Computer-Aided Systems Human Engineering and Collaborative Design Technology projects at the Armstrong Laboratory. It would allow design teams to engage in collaborative case-based reasoning about particular design situations. Satisfying the objective requires

software capable of providing: a) design apprenticeship, b) intelligent retrieval of design cases, c) conceptually-indexed design cases, d) case-based reasoning using indexed cases and learning classification techniques, and e) design brainstorming/editing methods. This captures the emerging collaborative design process, then supports this process by merging intelligent retrieval/search technology with computer-supported cooperative work functions. The major research challenge involves development of "design cases" which improve as a function of their use by multidisciplinary design teams. The usefulness of design case models is based on the premise of transforming design team members' characteristic errors (i.e., misconceptions which represent members' initial conceptualization about how they think they can explore the design space to get to the information they need) into potentially constructive learning experiences.

Phase I: Phase I work must contain: real world knowledge/design cases for the development and testing of the product; perspectives involving machine learning, computer-supported collaborative work, and conceptual indexing; an operational design of the product; an electronic storyboard documenting the use of the product; and a research plan for in situ evaluation involving design teams working on a specified human engineering design problem.

Phase II: Phase II work requires the actual development of the case-based/retrieval technology as a product for design communities. Once the product has been developed for operational utility, it may be validated in accordance with the test plan developed in Phase I. Based on evaluation of the performance with an actual collaborative design group, feedback can be used to propagate additional design changes as required.

Dual Use Commercialization Potential: At this point the general architecture of the product may be elaborated for use in other design domains. Case-based Reasoning/Retrieval Technology will be useful for commercial applications as it will provide a basis for business/industry to intelligently retrieve, distribute, index, and transfer design knowledge across a number of remote geographic locations involved in real world design processes. The commercially available product would enhance design team brainstorming techniques and act as an aid for design problem solving resulting in increases in the quality of designs while providing more efficient design support.

AF94-032TITLE:PC-Based Measurement of Situational Awareness Aptitude

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-Systems Interfaces

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop a PC-based synthetic task that assesses pilot applicants' potential for developing situational awareness.

DESCRIPTION: Situational awareness can be defined as the pilot's mental model of the tactical situation. Combat pilots in fighter, attack, and bomber aircraft each require situational awareness for their unique missions. Our working hypothesis, however, is that there is a core process of attaining and maintaining situational awareness common to all combat missions, and that pilots acquire skill in situational awareness with experience, and vary in asymptotic skill level. We are interested in identi- fying the cognitive and perceptual abilities that enable some pilots to develop the highest levels of situational awareness. This requirement is for a microcomputer-based synthetic task capable of training flight-naive subjects to pilot a simulated general purpose combat aircraft and perform various missions under multiple threat environments. The synthetic task should record and evaluate the appropriateness of the pilot responses to events built into each mission's scenario. The ideal system would employ multiple measurement procedures, each designed to measure a subject's performance in terms of situational awareness. The end product of this research will be a PC-based synthetic task requiring approximately 40 hours to complete, that assesses a person's aptitude for developing situational awareness. The synthetic task will be used as a criterion measure in laboratory studies of the cognitive and perceptual correlates of situational awareness.

Phase I: Phase I will result in the preliminary design of the synthetic task and an executable prototype.

Phase II: Phase II will be the full-scale development of the synthetic task, and proof of concept of the synthetic task's reliability and validity as a measure of situational awareness. Proposers should assume that the synthetic task will be hosted on a 80486/33 computer equipped with joystick and rudder pedals.

Dual Use Commercialization Potential: The synthetic task described above could result in several marketable products. First, the synthetic task could be sold to Allied and friendly nations for use in pilot selection programs in combat training programs; this would require a minimum of system modification. Second, the synthetic task could be tailored to the commercial airline and transport mission and marketed as either a selection or training system. Third, the synthetic task could be marketed as a performance assessment battery. Performance assessment batteries are used with increasing frequency to determine if the operators of vehicles or heavy equipment are psychologically fit for duty. They are also used in scientific research to determine the effects of acute changes, e.g., drugs or stress, and of chronic changes, e.g., aging, on performance. Fourth, the synthetic task could be marketed as a video game. The video game version of the task would not need the full performance evaluation module.

AF94-033TITLE:Design/Redesign for Supportability

CATEGORY: Exploratory Development

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop tools to better incorporate supportability considerations into any weapon system design and modification.

DESCRIPTION: This requirement is for supportability analysis and communication tools that will enable designers to better incorporate supportability considerations into the weapon system acquisition and modification process. Today's digital computer technology offers the design team tremendous potential to identify supportability problems earlier, to communicate supportability issues and solutions efficiently, and to ensure supportability is effectively incorporated into the design. The following areas are of interest: (Specify subtopic by letter)

a. Collaboration in the design/redesign activity requires effective discussion of design-related issues and the sharing of design-related information. There is a need for a tool that allows anonymous discussion of issues and the capability to create lists of alternatives that can be evaluated by members of the design team.

Phase I: Phase I will address tool architecture and the feasibility of using such a tool in the design process.

Phase II: Phase II will yield an Ada-based tool that works across multiple computer systems in a client/server environment.

Dual Use Commercialization Potential: The tools could be used for supportability design improvement in virtually any defense-related system or any commercial product that requires ongoing maintenance or logistics.

b. There is a growing need to provide environmental technical and regulatory information to a system designer. This information (regulatory data, pertinent governing policy, and lessons learned), when collected in a "data repository" tool, will aid in environmentally sound decision making during design.

Phase I: Phase I will define the functional requirements for such a tool, including potential data sources.

Phase II: Phase II will develop a prototype tool capable of storing, managing, and presenting this data in a useable format.

Dual Use Commercialization Potential: The tools could be used for supportability design improvement in virtually any defense-related system or any commercial product that requires ongoing maintenance or logistics.

c. Current methods for determining system effectiveness rarely analyze system effectiveness as employed in expected use scenarios. Needed are software tools that will allow predictive analysis of system effectiveness under its expected use conditions. Further, these types of analysis are generally conducted late in the acquisition process when results have little impact on basic design decisions.

Phase I: Phase I will develop generic methods to define and analyze performance and lifecycle design factors with respect to mission accomplishment.

Phase II: Phase II will develop software tools with an open architecture to allow easy integration of the design factors into other software simulation applications.

Dual Use Commercialization Potential: The tools could be used for supportability design improvement in virtually any defense-related system or any commercial product that requires ongoing maintenance or logistics.

AF94-034TITLE:Low-Cost, Field-Deployable, Binocular Head-Tracked Helmet-Mounted Display

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop a prototype field-deployable helmet-mounted display for squadron-level flight training devices.

DESCRIPTION: A low-cost, self-contained, helmet-mounted visual display system which will provide full color, wide field-of-view, high-resolution imagery to a pilot sitting in the cockpit of a flight training device is required. The display must be rugged and easy to use, and must contain an integral head-tracking device with only a remote sensor fixed to the cockpit. Supporting electronics may be located off the helmet but must be packaged compactly enough to integrate within the cockpit.

Phase I: Phase I will examine various approaches to building such a display and result in a proof of concept. Optics should have: (a) wide field of view; (b) >50% see-through transmission; (c) high efficiency (imagery >80% of the image source brightness); (d) high resolution; (e) high image quality; (f) flat object plane to accommodate flat image sources; (g) light weight; and (h) little or no adjustment necessary for eye separation distance of user. Image source should explore sources which can provide a bright, high resolution, i.e, 1 million pixels or more, light weight image source in a small image size (25 mm) which is compatible with the optics. Safety issues, such as the proximity of high voltages close to the head, shall be considered. Head-tracking device must be inexpensive and unobtrusive, consisting of an emitter array and a sensor. The device must be insensitive to ambient noise and have sufficient resolution and signal-to-noise ratio to support the high resolution of the display system. Explore head movement prediction algorithms capable of negating system lags or latencies of up to 150 msec without adding noise.

Phase II: Develop two or more prototypes which incorporate the Phase I technology. These should be designed to validate the concept and serve as tools to gather information in areas Phase I was unable to explore. The contractor will quantify the performance of the prototypes and recommend further requirements. The helmet displays developed should have the potential for refinement to a production version be serviceable in the flight training environment, and for applications outside of flight training areas such as remote presence and virtual environments.

Dual Use Commercialization Potential: Any production version of this helmet display has the potential for application in civilian flight training environments and for other applications requiring high-fidelity information display, such as remote presence and virtual environments.

AF94-035TITLE:Development and Presentation of Electronic Technical Data for Maintenance

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop improved technologies for developing/presenting electronic technical manuals for use by aircraft maintenance technicians.

DESCRIPTION: The DOD and industry are rapidly moving toward the implementation of electronic technical manuals to support aircraft maintenance. Although the basic technology exists to implement electronic technical manuals, there are many research opportunities to develop improved techniques for developing and presenting technical data. (Specify subtopic by letter)

a. Research is needed to identify, develop, and test electronic information display devices which improve over small, special-purpose portable computers, which are often limited in their capability by such things as work space.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested promising technologies.

b. Research is required to develop innovative techniques to present maintenance technical data (currently displayed as large graphics such as schematics and wiring diagrams) in a simplified graphic or nongraphic format on a small computer so it is easily understood and used by the technician.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in a full-scale test of the most promising technologies.

c. Research is needed to develop techniques to present technical data for maintenance in an easily understood manner which does not require strong reading skills.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested technologies.

d. Research is needed to automate all, or major portions of, existing technical data into an electronic technical manual technology to be used on already fielded systems and to remain in inventory for several years.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested technologies and software.

e. Research is needed to develop technologies to automatically generate electronic technical data from computer- aided design data bases, which are used for design of weapons systems and maintenance instructions. Much of the information currently is extracted manually and entered into the maintenance technical data system.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested technologies and software. electronic technical data from the computer-aided design data bases.

Dual Use Commercialization Potential: The research needs described below are for the development of technologies needed to more effectively present and more economically develop electronic technical manual systems to support the maintenance of complex equipment. The technologies are applicable to the development and presentation of electronic technical manuals for the maintenance of any complex equipment, including automobiles, aircraft, ships, computers, and industrial equipment. Applications of the technology are unlimited.

AF94-036TITLE:Improvements in Life Support Personal Protective Equipment and Altitude Diagnostic Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-Systems Interfaces

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop low resistance breathing system; develop decompression/denitrogenation computer for real-time risk
prediction.

DESCRIPTION: Specific areas include the following: (Specify subtopic by number)

a. Flow resistance imposed by current aircraft oxygen systems limits delivery of breathing gas to the crewmember. High breathing resistance adds stress, discomfort, and distraction to the high workload flight environment. Inspiratory resistance may reduce high acceleration (G) tolerance by decreasing the effectiveness of respiratory straining maneuvers. Current systems fall short of international standards and produce abnormal respiratory gas exchange which may also contribute to episodes of hypoxia. Design changes to include low resistance components are needed to advance development of these systems toward adequate breathing gas delivery and compliance with these standards.

Phase I: Phase I efforts will identify design changes for components which contribute to breathing resistance.

Phase II: Phase II will produce a brassboard low-resistance breathing system including components beginning with the regulator and downstream to the protective oronasal mask.

Dual Use Commercialization Potential: Applications for personal protective breathing systems with reduced breathing resistance include respirators for the personal protection of workers in environmental cleanups and toxic materials waste removal and disposal, as well as others working in toxic atmospheres, such as firefighters.

b. Develop advanced decompression/denitrogenation computer algorithms for real-time assessment and prediction of decompression sickness risk. High-altitude exposures in aircraft, in hypobaric chambers, and with extravehicular activity (EVA) in space result in an inherent risk of decompression sickness (DCS). In the past, general guidelines for safer altitude exposures have been developed through costly, time-consuming studies, each specific to unique scenarios of altitude exposure. The results of these studies are often difficult to apply to other operational

altitude requirements. New, time-consuming studies must therefore be undertaken. Rapidly changing technology in aircraft design dictates improved capability for decompression risk assessment. In recent years the altitude ceiling of private, general aviation aircraft with unpressurized cabins has been rising, thus exposing the occupants, both pilot and passengers, to the hazards of high- altitude decompression problems. Data bases exist for the development of a standardized altitude decompression/denitrogenation model, such as exists on diving decompression computers. Computer algorithms for altitude are needed for both real-time DCS risk information, as well as DCS risk predictive capabilities.

Phase I: Phase I will develop the software program for the decompression model.

Phase II: Phase II will provide a hardware prototype for further operational development assessment.

Dual Use Commercialization Potential: Utilization of such hardware is anticipated in aircraft cockpits, or hypobaric chamber control stations, in EVA suits, in commercial and private general aviation aircraft, and as operational mission planning computers for high altitude.

AF94-037TITLE:C3I Systems/Subsystems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop innovative concepts for increasing warfighting capabilities of the Air Force command, control, and communications systems or subsystems.

DESCRIPTION: Proposals may address any aspect of AF C3I systems not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, C3I concepts for: Fixed and mobile command centers; tactical operations; special forces operations; AF ground-based or early warning systems; AF mobility issues. Also of interest are: mission support system planning tools; innovative methods for employing commercial off-the-shelf communications technology; innovative approaches to modeling the cost of C3I system ownership, and to the reduction of life cycle cost; decision analysis tools for determining the optimum C3I system maintenance level; IDEF2-5 tools/methodologies. This topic offers great flexibility for proposers to offer solutions to AF C3I problems.

Phase I: Provide a report describing the proposed concept in detail and show its viability and feasibility.

Phase II: Fabricate and demonstrate a prototype device or subsystem or software program.

Dual Use Commercialization Potential: All solutions proposed must have potential for use/application in the commercial as well as military sector, and potential commercial applications must be discussed in the proposal. Proposal titles must reflect the specific C3I and problems being addressed.

AF94-038TITLE:Innovative C3I Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop innovative technologies for enhancing the performance, availability and affordability of C3I systems and subsystems.

DESCRIPTION: Proposals may address any aspect of C3I pervasive technologies not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, innovative concepts and technologies in: signal image and speech processing, computer science, including software engineering, computer systems technology and artificial intelligence, electromagnetic technology, including phased array antennas, null steering and scattering, superconductive electronics and EM materials and components, photonics, including optical memory, processing, devices and materials and reliability and diagnostic technology. This topic offers great flexibility for proposers to offer innovative technologies with revolutionary impact on C3I systems and subsystems.

Phase I: Provide a report describing the proposed concept in detail and show its viability and feasibility.

Phase II: Fabricate and demonstrate a prototype device or subsystem or software program.

Dual Use Commercialization Potential: The C3I technologies all have substantial dual use potential and will impact competitiveness and performance of the commercial sector as well as the military sector.

AF94-039TITLE:Three Dimensional Optical Storage Medium

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop Optical memory media to be employed in a practical memory architecture.

DESCRIPTION: Three dimensional optical storage has not been incorporated into modern systems due to a lack of a practical media. Present storage media does not work at ambient temperatures, and cannot use laser diodes for both read and write applications. Future applications will require huge amounts of data storage capacity (at least 10E12 bits). Read/write operations should accommodate gigabit to terabit throughput rates; and have a persistence of long periods of time (months). Architecture should include fast (100's of nanosecond) access times.

Phase I: Identify candidate media and characterize the optical properties with respect to writing energy, recording time, dynamic range, storage density, and crosstalk.

Phase II: Incorporate this media into a usable architecture.

Dual Use Commercialization Potential: Optical Memory "will have" tremendous impact on today's storage and retrieval community in the fields of medicine, computer memories, data handlers, etc.

AF94-040TITLE:Photonic Interconnects

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop advanced photonic interconnects for improved digital signal processing and computing systems.

DESCRIPTION: Ultra-high throughput optical or hybrid opto-electronic digital signal processing and computing capability is required for global C3I surveillance and command and control / intelligence functions in future military and commercial systems. Research and development efforts, in the general area of optical interconnects, including significant collaborative interaction between in-house and contractual high pay-off technology solutions. Photonics Center and Rome Laboratory resources, including state-of-the-art optics laboratories, devices, and photonic test instrumentation, as well as device fabrication capabilities, operational radar systems, and other Rome Laboratory-developed technologies are available as GFE or GFP for such subsystem demonstrations. Innovative R&D is sough to address problems such as the development of: surface-relief diffractive optics for broadcast and N-to-N general interconnects, and fixed and reconfigurable
Collaborative phase 2-D polymer waveguide clock distribution and 3-D free-space gate-level interconnects, multichip-module chip-to-chip interconnects, and wafer-scale / board-to-board interconnects, and integrated optical crossbar switches.

Phase I: Demonstrate feasibility of the photonic interconnect technology and develop a demonstration plan for Phase II.

Phase II: Demonstrate a full-up and well defined collaborative multichannel electronic computer interconnect demonstration, involving greater than 100 channels at bit transfer rates greater than 100 MHz, in the Photonics Center, performing an interconnect function traceable to a well defined signal processing problem.

Dual Use Commercialization Potential: The potential for dual commercial use of DoD-developed photonic

interconnect technology is great. Commercial computing technology will certainly utilize optical interconnects in the near-term due to speed, power, crosstalk and interference, and reliability advantages.

AF94-041TITLE:Optoelectronic Processors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop advanced hybrid photonic-electronic processing and computing systems.

DESCRIPTION: Ultra-high throughput optical or hybrid opto-electronic digital signal processing and computing capability is required for global surveillance and command and control / intelligence functions in future AF systems. Subsystem development efforts, in the general area of opto-electronic processors, including significant collaborative interaction between in-house and contractual researchers conducted partly in the AF Photonics Center, are desired to provide near-term application-oriented technology solutions. Photonics Center and Rome Laboratory resources, including state-of-the-art optics laboratories, devices, and photonic test instrumentation, as well as device fabrication capabilities, operational radar systems, and other Rome Laboratory-developed technologies are available as GFE or GFP for such subsystem demonstrations. Collaborative phase I feasibility experimentation will lead to a well-defined phase II working prototype demonstration in the Photonics Center. All efforts should be designed to ultimately address a specific AF processing problem. Specific areas of interest are: Applications-oriented development of massively parallel monolithic opto-electronic hybrid smart pixels and circuits for use in ultra-high speed massively parallel digital processors, including GaAs and InP, and silicon-hybrid technology.

Phase I: Should demonstrate feasibility via a collaborative interaction involving the Photonics Center and its resources, and develop a demonstration plan for phase II.

Phase II: Should involve a full-up and well defined collaborative signal processing demonstration in the Photonics Center, potentially including real-time radar processing, operating with throughputs greater than 1 GOps.

Dual Use Commercialization Potential: Commercial high performance computers are primary targets for the technology. The development of photonic and electronic "highways" will provide significant market potential for hybrid opto-electronic machines which can be applied to medical data transfer, and distributed design/manufacturing capabilities.

AF94-042TITLE:Photorefractive Materials and Devices

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop high speed, high sensitivity photorefractive materials and devices for real time optical signal processing.

DESCRIPTION: The photorefractive effect can be utilized in many photonic system designs. A current need exists for photorefractive materials with fast response times at moderate intensity levels, responsitivity in both the visible as well as near infrared, and good sensitivity. Specific areas of interest are materials with response times of less than 1 msec at intensities of 10 mW/cm2, operating at wavelengths of 830-850 nm, and providing diffraction efficiencies of greater than 3%. Proposals are requested for production of materials meeting the above requirements for applications such as optical correlations and integration.

Phase I: Demonstrate feasibility of the growth of photorefractive materials with high speed and sensitivity in visible or near infrared. The contractor shall deliver a prototype material at the end of Phase I.

Phase II: Optimization of the photorefractive materials production and photorefractive characterization for commercialization.

Dual Use Commercialization Potential: These photorefractive devices are commercially applicable to robotics, machine vision, assembly line monitors, and sorting.

AF94-043TITLE:Advanced Signal Processing Concepts for C3I

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop advanced signal processing algorithms and architectures for real time multi-function and multi-sensor system applications.

DESCRIPTION: Future and upgraded surveillance systems will have signal processing requirements which constantly grow and exceed the capabilities of today's technology. The development of artificial intelligence and numerical algorithms will support sensor requirements of detection, tracking and identification. These complex algorithms also demand processors with high throughput, high internodal communications with substantially reduced size, weight, and power requirements. To meet these challenges, signal processing architectures and hardware must be flexible and adaptable to permit growth, and upgrade of processing components without change in the fundamental architecture. In addition, packaging signal processing systems in smaller volumes, with accompanying reductions in size and power, and an increase in the bandwidth between parts of the processing system are critical platform and portability requirements. Open system interconnect concepts will assure graceful upgrade ability and lower life cycle costs. However, these advantages must not come at the expense of programmability or design time. Innovative concepts in the following specific areas are of interest: interconnect bandwidth using Electro-optic interconnects; increased density by the use of Hybrid or Monolithic Wafer-Scale Integration (HWSI, WSI) in both two and three dimensions (stacking of substrates); open systems interconnect (OSI); real time fault tolerant support;rapid prototyping; artificial intelligence or knowledge-based techniques; and efficient use of numerical methods.

Phase I: A phase I contract will involve analysis and trade-offs for advanced algorithms, architectures and packaging technologies and how to rapidly prototype and implement the proposed design.

Phase II: Phase II will involve the demonstration of advanced concepts using a prototype system and implementation at Rome Laboratory's Surveillance Facility.

Dual Use Commercialization Potential: Commercial application for high performance processors in small packages are highly desirable for desktop workstations and portable instrumentation equipment.

AF94-044TITLE:Advanced Information Fusion Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Development of new all-source data fusion technology applied to distributed environments.

DESCRIPTION: Data Fusion has been defined (Joint Directors of Laboratories (JDL) Technology Panel on C3 (TPC3), Data Fusion SubPanel (DFSP)))as: "Information processing that deals with the association, correlation, and combination of data and information from single and multiple sources to achieve refined position and identity estimation, complete and timely assessments of situations and threats, and their significance in the context of mission operation. The process is characterized by continuous refinement of its estimates and assessments, and by evaluation of the need for additional sources, or modification of the process itself, to achieve improved results." Current data fusion techniques beyond Level-1 (correlation) are mainly manual and cannot keep pace with the highly mobile, dynamic forces likely to be faced in the future. Current Level-1 fusion techniques only support limited sources, not all-source information. In addition, distributed data fusion is currently not available. This topical area will address advanced computing technologies for all-source data fusion, as well as distributed data fusion.

Phase I: Phase I will investigate advanced computing techniques (e.g., statistical, artificial intelligence, artificial neural networks, fuzzy logic) applicable to all-source data fusion. Phase I will result in a detailed plan and prototype software, which demonstrates the feasibility of a potential Phase II effort.

Phase II: Phase II will develop, implement, and demonstrate the advanced computing techniques applicable to all-source data fusion, as well as distributed data fusion, recommended in Phase I.

Dual Use Commercialization Potential: This topical area has dual-use potential wherever data from different (or even similar) sources are required for decision making. Examples of potential industries include: drug enforcement/ interdiction, medical, environmental, aerospace, automotive, and manufacturing.

AF94-045TITLE:Advanced Infrared Sensor Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop innovative concepts in infrared (IR) sensor technology for improved detection, track, identification and navigation.

DESCRIPTION: Infrared sensor systems are an important part of any C3I system. Operation in a passive mode allows for both covert and autonomous operation which is often important in military missions. As such, IR can be an important adjunct to active radar which will allow for improved system effectiveness and enhanced data collection in battle. Infrared sensor systems need to be developed toward providing for increased survivability of future surveillance platforms and assured detection and tracking of ground, airborne, and theater ballistic missile threats. Most current sensor systems are based on line scanners and require complex optical and electronic support. The next generation of IR sensors must be simpler, driving system designs to staring operation, resulting in improved system reliability, lower cost and enhanced target discrimination. The heart of any IR sensor is the Focal Plane Array (FPA) which has detectors (pixels) in an x-y format. Current technology uses FPA's having more than 300,000 (480x640) pixels that can be fashioned into extremely high definition sensors with a small IFOV. Future FPA's will have more than one million (1040x1040) IR pixels and will be ideal for the long range surveillance mission. Current large format FPA's operate in the Midwave Infrared (MWIR) band, which is suitable for most atmospheric missions. Future growth of these large staring arrays into the Longwave Infrared (LWIR) band is anticipated and enhanced target information will be available from dual band operation. In addition, exploitation of their full capability is subject to the advantageous use of optimizing processing methods such as advanced frame to frame registration and clutter suppression techniques. The innovative concept should show promise of producing a performance improvement over current state-of-the-art. Improved infrared sensitivity, greater signal to noise ratio, enhanced spectral coverage, lower cost and improved MTBF are examples of desired performance enhancements. Areas of interest include but are not limited to infrared sensors, sensor systems, focal plane arrays, signal processing, and data processing.

Phase I: Develop the concept for advanced infrared sensor technology in sufficient detail for a feasibility determination to be made, perform an analytical evaluation of the concept, and perform a simplified simulation analysis of the concept.

Phase II: Develop a prototype of the concept for advanced infrared sensor technology. Perform detailed analyses of its overall performance and of its performance with respect to the most applicable mission for the concept. Perform an analysis to determine failure modes as well as to determine other, less critical weaknesses.

Dual Use Commercialization Potential: Infrared sensors have found only limited use for commercial applications because of high cost. New IR sensors based on low cost, staring FPA's will be more affordable and can be used by law enforcement, fire fighters and medicine. Advanced sensors must have both lower cost and improved reliability for commercial success.

AF94-046TITLE:Self Organizing Database Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop automated tools/testbeds to evaluate self organizing heterogeneous database solutions to intelligence database deficiencies.

DESCRIPTION: This topic area addresses high priority needs in the area of data base technology and data organization. The effort will apply advanced mathematical techniques such as Complexity Theory, Chaos Theory, Catastrophe Theory, Genetic Algorithms, Neural Networks, and Case Based Reasoning to the problem of organizing huge amounts of unstructured data of heterogeneous type into a repository that clusters data by concept and relevance.

Phase I: Phase I efforts will develop the specification of a testbed for the evaluation of self organizing database techniques.

Phase II: Phase II efforts will be the implementation of a testbed, including databases and measurement software for the evaluation of different approaches to self-organizing database systems.

Dual Use Commercialization Potential: The topic has dual-use potential use in the aerospace, financial, medical, and manufacturing industries. Advances in the technology of information systems and the accesses to multiple heterogeneous data bases are driving drastic changes in the frequency and ways that organization are requesting information. A variety of advances in mathematical techniques, and data models provide potential solutions to many of the technical problems that must be addressed by information oriented industries as it is driven by these changes.

AF94-047TITLE:Speech Segmentation in Noise

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Development of algorithms to improve speech segmentation for improved speech processing.

DESCRIPTION: Current speech recognition and coding algorithms were developed to operate with clean speech inputs. This approach assumes an ideal situation and has limited application in the real world. Communications are often contaminated with noise (both acoustic and electrical) that causes rapid degradation in the performance of these algorithms. A key element in the algorithm degradation is the inability of the algorithms to dissect the speech signal into its components parts. This effort will develop a method to automatically segment speech in a noisy environment for subsequent speech recognition and coding. The capability to perform this type of segmentation on operational type signals is fundamental to the successful field implementation of speech recognition functions such as automatic word recognition, speaker identification, and speech coding.

Phase I: Develop methods to automatically and accurately segment noisy signals into voiced, non-voiced, and background (silence/noise).

Phase II: Develop methods to perform intraword segmentation for speech understanding and improved coding performance.

Dual Use Commercialization Potential: This topical area has dual-use potential in the medical, automotive, and aviation industries.

AF94-048TITLE:Portable Language Translation Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop a field deployable machine aided voice translation system.

DESCRIPTION: There are a wide variety of military and commercial applications for which automatic speech translation, that is, the translation of spoken input in one language into spoken output in another language, would be useful. Although there has been some success in the development of very rudimentary systems, significant research must be performed to provide a highly capable, easily transportable form of this technology.

Phase I: Develop software systems which combine automatic speech understanding, machine translation, and speech generation; individual components that may be incorporated into such systems, and other possible media components that might be introduced into a spoken language translation system to determine the feasibility of utilization for spoken language translation in a portable system. Design a field-deployable spoken language translation unit fro use in a wide variety of mobile applications (vehicles, aircraft, ships).

Phase II: Develop a field-deployable prototype of an existing spoken language translation system and incorporate that system into a selected mobile environment.

Dual Use Commercialization Potential: This topic area has dual-use potential in providing translation at international meetings, as a tourist travel aid, in law enforcement query and as an aid in multi-national military operations.

AF94-049TITLE:Digital Cartographic Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop software to enhance the operation of common mapping data structures and application tools.

DESCRIPTION: Standardized cartographic tools, applications software and common cartographic data formats have been developed to support a wide range of Air Force weapon systems that have requirements for digital maps and related products. Many of these developments have already found use in operational systems and will be maintained under configuration management as standards. Current effort is in progress to implement cartographic data sets and tools in sophisticated client-server structures on distributed networks to foster efficiency and interoperability. In spite of these successes, problem areas remain to be resolved. One specific area of interest concerns accurate registration of imagery and digital feature analysis data (DFAD) with gridded elevation data. Because of variations in scales, accuracies and formats registration of elevation data to imagery and DFAD, based simply on given coordinate values has not provided good results. The basic problem results from a lack of well defined features and feature prominent points in the elevation data that are common to features in the imagery and DFAD data, and which could be used to obtain accurate registration. This effort will seek to develop software techniques for extracting features from gridded elevation data which are common to imagery and DFAD features and can form the basis for accurate registration of the three data types. This will permit merging of the image grey scale values and vector features with the corresponding elevation data to enable accurate perspective view display rendering. A further goal of this effort will be to develop automated techniques for extracting the elevation features and automated techniques for accomplishing the subsequent registration process.

Phase I: Proof of Concept. Develop and prototype approaches for extracting common features in elevation image and DFAD data products for purposes of automated registration of all three products.

Phase II: Fully demonstrate automated extraction of features from gridded elevation data sets and demonstrate accurate, automated registration with imagery and DFAD products over the same area.

Dual Use Commercialization Potential: This technology has dual use potential for applications that involve the use of digital maps for land resource management, city planning and regional development, forest conservation and similar applications where interrogation and display of earth surface features is needed.

AF94-050TITLE:Intrusion Prevention Systems

CATEGORY: Exploratory Development

OBJECTIVE: Provide technology which will assure the physical security of a wide variety of facilities.

DESCRIPTION: Innovative approaches are sought in two aspects of intrusion detection and prevention: a. Development of a portable video assessment system with wireless video transmission capability which would allow security personnel to quickly determine the actual cause of an alarm and its validity. Effort would consist of analyzing requirements and revising and evaluating advances in technology and products which may be applicable. b. Study and identification of possible countermeasures which could be applied against state-of-the-art intrusion technology and development of adequate responses (counter-countermeasures) to identified threats.

Phase I: Would be a feasibility study applied to a typical area requiring protection and would identify possible countermeasures to existing physical and perimeter control technology.

Phase II: Would develop a working prototype which would apply identified methodology/processes to the fabrication, testing, and use of the identified countermeasure techniques, devices, and materials.

Dual Use Commercialization Potential: Results of this effort would be useful for any business, industry, or government function which requires protection of an area from intruders. This could include factory sites, transportation facilities (airports, railroad yards and track facilities, truck terminals, dock areas), prisons, retail stores, office buildings, and banks.

AF94-051TITLE:Electromagnetic Interface Design Tool (TDE)

CATEGORY: Exploratory Development

OBJECTIVE: Develop a computer-aided-design tool to minimize electromagnetic interference (EMI) on printed circuit (pc) cards and laminae.

DESCRIPTION: Software would evaluate the extent of EMI by calculating switching rates, spectral characteristics, oscillator frequencies, voltage and current values, pc layout parameters, power filtering, logic device capacitive coupling and decoupling, and attenuation and resonance effects. The resulting display would be a color-coded image of the pc indicating the EMI hotspots; a contour map and associated printout of predicted EMI levels would be provided.

Phase I: Provide a report describing the proposed concept in detail and showing its viability and feasibility.

Phase II: Fabricate and demonstrate a prototype software program.

Dual Use Commercialization Potential: Successful results of this effort would be immediately applicable to the electronics industry and could be incorporated into the standard suite of printed circuit design software tools.

AF94-052TITLE:Robust Planning Technology in Uncertain Situations

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop feasible methods for specifying military plans considered robust by military experts.

DESCRIPTION: Automated techniques for generating military plans are being developed using Artificial Intelligence (AI) planning and scheduling techniques. These techniques have been demonstrated to support the rapid, accurate and efficient creation and modifications of plans for use in various operational environments with little uncertainty. However, the optimization criteria used in current knowledge engineering methods (usually embodied in heuristics, utility functions, etc.) do not capture the military planners' notion of robustness in a partially known environment. For instance, one measure of robustness to a planning technologist could be the ability of the system to backtrack through a search space of plan representations, while to a military planner it could be the ability to replan in response to changes in the real world situation. Equivalent definitions of robustness, one understandable to military planners and the other understandable to planning and scheduling researchers are needed.

Phase I: In Phase I the offeror shall develop optimization criteria that embody equivalent definitions of robustness and implement a small scale prototype embodying the developed robustness criterion, and analyze its

computational complexity. Phase II: In Phase II the offeror shall use the proposed techniques to plan against standard scenarios selected in cooperation with the government, and shall instrument the implementation to facilitate meaningful comparisons with other techniques.

Dual Use Commercialization Potential: Robust knowledge-based planning technology will be applicable to a wide range of planning, scheduling, and resource allocation problems in diverse fields such as manufacturing, logistics, transportation and environmental planning, etc. These applications differ only in the degree to which the plans are unique, the rate at which changes occur during plan execution or to the goal structure upon which the plan is based, and the temporal, causal, resource and task complexities of the plan.

AF94-053TITLE:Technology for Building Large Scale Knowledge-Based Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop techniques and tools for use in the implementation of quality, robust, large-scale knowledge-based systems

DESCRIPTION: This technology program focuses on innovative research investigations to identify new methods for the design, integration and evaluation of intelligent functionality in software. Investigations in the following five areas are of interest: 1) techniques for behavior certification of AI software including verification techniques, performance assessment via learning, and minimum competency (fail safe); 2) integration techniques for knowledge sharing and reuse, distributed knowledge bases; 3) new AI software acquisition methodologies including techniques for behavioral requirements specification, quality assurance; 4) knowledge acquisition methods enhancing knowledge discovery in massive multimedia databases while exploiting high performance computing mechanisms; and 5) AI techniques for simulation modeling and simulation development environments.

Phase I: Phase I efforts will investigate the feasibility of developing promising techniques.

Phase II: Phase II will implement Phase I techniques and demonstrate feasibility on both military and commercial application domains.

Dual Use Commercialization Potential: A mature knowledge-based systems engineering technology will fill gaps in existing approaches to multi-function integration, system level design, performance evaluation and system acquisition. New tools can provide gains in development time and cost for large-scale commercial applications equal to those for similar military applications. Currently cost and risk is so overwhelming that many important large-scale developments cannot be undertaken without undue risk. This technology could have major impact on applications such as nuclear power plant control, autonomous vehicles, aircraft operation, hospital life support systems, decision support systems, and military command and control.

AF94-054TITLE:Distributed Information Systems Resource Management

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop mechanisms which will provide uniform control over the combined networking and processing resources which together make up a distributed information system.

DESCRIPTION: The trend in information systems technology is toward large, multi computer distributed information systems which must support the uniform access to globally distributed data under varying conditions of load, required response time, user model and external environment. The processors which are being developed provide

orders of magnitude increase in computational power, while the interconnecting networks are approaching gigabit speeds. To effectively harness this new capability in a cohesive system which can dynamically respond to widely varying conditions it is necessary to abandon many of the current paradigms which treat the computers and the communication as discrete entities, with little or no concept of integrated resource management, and develop new mechanisms. In this new model the user/application is the controlling element which provides to the system resource manager the necessary information to optimize performance. For example, in an air traffic control system, if an overload could include reallocation of communications links, reallocation of processing elements, shedding of lower priority tasks, etc. All of this would be accomplished under a policy specification pre-existing in the system. To effectively accomplish this a uniform object model representation of all of the resources must be developed. Mechanisms must be incorporated which can translate system state parameters and application model definitions into configuration parameters. The final capability would be demonstrated on a local cluster configuration.

Phase I: Develop a characterization of the object model to control a local cluster composed of high performance workstations interconnected by an set of ATM communications links. The configuration should support distributed shared memory, global object identification and uniform process control across the configuration.

Phase II: Implement the basic object model on a three node configuration to demonstrate the resource reconfiguration capability based upon application specified parameters.

Dual Use Commercialization Potential: This technology will be equally applicable for distributed command and control systems for the DoD, air traffic control information handling systems for the FAA, global financial transaction systems for the banking and investment community, etc. As the telecommunications innovation drives the interconnection of ever larger numbers of computers, the need for these global resource management mechanisms will become ever more important for all segments of the economy.

AF94-055TITLE:Data Management for High Performance Computing

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: The objective of the effort is to develop tools and techniques for finding a solution to storage access problems associated with high performance computing (specifically, massively parallel computers in heterogeneous systems).

DESCRIPTION: The world of high performance computing provides a capability for significant gains in overall system/software throughput. However, these performance gains are often not up to expectations due to limitations in the way data is accessed and other input/output limitations. In particular, concurrent access to and from files in secondary storage is a critical problem that hinders parallel processing effectiveness due to the low physical bandwidth between the processors and disks, thus creating a bottleneck in the system. Software methods of obtaining high bandwidth data I/O where physical bottlenecks exist, needs to be investigated as one possible solution to the storage access problem currently associated with high performance computing. Software tools and techniques are required that will automate or simplify the process of designing and handling concurrent queries into disk systems with greater efficiency and ease of use. Such tools will be capable of assisting the engineer in the decomposition of data into a usable format on single or arrays of disks. This decomposition will provide to the programs executing on homogeneous or across heterogeneous systems, the means to utilize the data in the most efficient manner. Finally these tools will provide greater ease-of-use for programmers to access to parallel file systems found in today's newer systems.

Phase I: The work to be accomplished in Phase I will provide new and/or significantly improved software engineering capabilities to examine, develop, prototype, and demonstrate advanced data management techniques, particularly in the high performance computing domain.

Phase II: Efforts undertaken in Phase II will concentrate on taking the design and demonstratable prototype provided in Phase I and follow through with a full data management for high performance computing development process to deliver an operational prototype tool.

Dual Use Commercialization Potential: The underlying scope of the research to be performed in this endeavor is applicable to a wide range of high performance computing systems, and is very generic in nature. As such, it

possesses significant application to the development of a number of commercial computer and software systems in such arenas as the aerospace industry, the automotive industry, banking/finance fields, as well as medical related activities.

AF94-056TITLE:Self-Healing Communications Networks

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop advanced technologies to support survivable communications networks that are able to adapt to dynamic topology changes.

DESCRIPTION: As efforts continue to extend computer and communications networks as far into the battlefield as possible, managing and configuring these networks becomes increasingly difficult. The battlefield theater environment is vastly different from the traditional environment communications networks were initially developed for. Traditionally, networks have existed in stable locations and changes were allowed to the network configuration only after careful consideration of the impact to the overall network. In the war fighting theater of the very near future, elements of a communications network may change locations, transmission media or traffic types as they move about the theater. Such changes will be dictated by battlefield conditions and the network will have no choice but to adapt. As elements in the theater move about (or cease to exist), the network must be able to reconfigure (or "heal") itself, without interrupting the integrity of the network. To accomplish this, routing and management schemes need to be developed which can adapt quickly and without human intervention.

Phase I: Phase I is expected to investigate the feasibility of implementing self-healing protocols and hardware for the theater environment.

Phase II: Phase II should produce actual implementations of demonstrable protocols and hardware that would allow the concept of a self-healing network to be demonstrated and explored in a laboratory environment that simulates the actual theater conditions.

Dual Use Commercialization Potential: This topic has dual-use potential in the telecommunications, data-communications and mobile telephone industries.

AF94-057TITLE:Virtual Environment Systems Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop techniques to provide enhanced visualization and input to a synthetic user environment.

DESCRIPTION: State of the art display technology is currently limited primarily to portraying two dimensional full color high resolution graphics. Recent advances in both the computing and display area have resulted in prototypes of synthetic, virtual reality environments which have the potential to revolutionize the use of computers for simulation, training and command and control. These environments provide the capability to interactively display and manipulate both static and dynamic data having three dimensional form and position. It can encompass terrain and feature data, natural phenomena such as clouds and weather, man made structures and obstacles, and allow the user to navigate thru the environment sensing the visual, auditory and tactile sensations. To make these environments practical there are numerous technical obstacles that must be overcome. One of these deals with the mapping of multiple resolution display images which may be both live and synthetic, originating from multiple sources onto a common high resolution display surface, couple with innovative environmental sensing technology.

Phase I: Investigate and design innovative mechanisms for the sensing and displaying the common mapping

format described above.

Phase II: Prototype the capability investigated under Phase 1

Dual Use Commercialization Potential: The use of virtual environments has already occurred in the entertainment area, and has potential usage in numerous other commercial areas. Its use as a training vehicle, design and diagnostic tool and simulation environment have all been well documented. The underlying technology is the same whether we are considering DoD or commercial applications.

AF94-058TITLE:Intelligent Design Tools

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Development of knowledge-based tools providing intelligent assistance for formal design, development, and maintenance processes.

DESCRIPTION: This effort will support transition of technology developed in the Knowledge-Based Software Assistant (KBSA) program into commercial products. The KBSA is an ongoing research program to improve software quality and reduce cost. The fundamental principles of KBSA are: 1) all processes and products are formally represented; 2) iterative development and validation of a specification are emphasized; 3) maintenance activities are indistinguishable from development; and 4) all activities are computer mediated and assisted. Proposed research should adhere to the KBSA principles but may explore applicability to other domains and enhancement beyond its software development focus. In addition to these principles, the following characteristics are desirable: (1) all objects and actions should be represented in a mathematical formalism to enable automation and intelligent assistance;(2) informal and familiar abstractions should be provided to support user interaction; and(3) a formal specification should be derivable from the abstractions and play a central role in any product. Specific areas of interest are tools related to software development and support activities, system engineering, hardware design, facility design, platform design, and process design and enactment.

Phase I: Phase I of this SBIR would result in a demonstration of the feasibility of the proposed product and a functional specification and operational concept document.

Phase II: Phase II would result in a prototype implementation of the proposed design tool and a system specification suitable for subsequent product development.

Dual Use Commercialization Potential: This technology area is domain neutral and is of greater potential benefit as a commercial product than as a purely defense related product. Design and process automation are cost and quality drivers and can provide a competitive edge in any market.

AF94-059TITLE:Indium Phosphide Componentry for Microwave, Millimeterwave, and Digital Systems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop low loss microwave and high speed digital components and devices.

DESCRIPTION: Recent developments in Indium Phosphide-based technology clearly show superiority over Gallium-Arsenide devices in terms of speed, frequency of operation and bandwidth. When this material is incorporated into components, applications will enable a significant increase in data throughput capability, while at the same time lowering cost, power and weight requirements. Innovative research for the applications of this material includes but is not limited to monolithic millimeterwave transmit and receive components for phased-array antennas, data processing, and switching terminal applications. Examples of components needed include oscillators, amplifiers, mixers, filters, isolators, circulators and antenna feed structures. Research to develop digital technology such as A/D converters (18

Bit, 100 MHz), shift registers, signal processing and data switching circuits is desired. Electronically variable ways to control amplitude, phase, or time delay in electrically large, wideband phased arrays are of interest. Innovative, monolithic, phased-array elements are needed. Improved design models are needed for millimeterwave Indium Phosphide High Electron Mobility Transistors on materials optimized for power applications. Approach here would require excellent knowledge of semiconductor physics and could utilize Rome Laboratory in-house experimental measurements.

Phase I: The contractor should identify a specific indium phosphide component or technology area for innovative research, perform preliminary design or analysis, evaluate critical elements, and perform preliminary experiments to clearly demonstrate technical feasibility of the concept.

Phase II: A Phase II contract will require design, fabrication, test and delivery of a prototype indium phosphide component or, for modeling work, successful prediction of device performance.

Dual Use Commercialization Potential: The civilian need for EHF communications and data highway technology eventually will grow as fast in the civilian sector as it is currently expanding in the DoD. Among many civilian applications are geosynchronous and low-earth orbit communications satellites capable of handling multigigabit data streams; commercial conformal antenna arrays and terminals on aircraft for crew and passenger data links via satellite to ground; conformal antennas and terminals on automobiles and trucks for navigation, communication and avoidance radar applications on the "smart" highway of the future; and commercial and residential antennas and terminals for data highway applications.

AF94-060TITLE:Multifunction Radio Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate radio and adaptive speech compression technology which supports theater extension for global communications (Global Reach/Global Power).

DESCRIPTION: The US has a global communications requirement to enable rapid application of air combat power via assured connectivity with timely, reliable, responsive, yet affordable, dissemination of information from HQ's down to the lowest, mobile, tactical force elements. The AF needs innovative research to enhance our ability to transfer large amounts of data, quickly, accurately, and securely. Researchers must identify promising communication technologies which will provide substantial immunity to hostile action (electronic warfare), maintain connectivity in the face of battle damage (link outages), meet requirements for high performance in capacity and timeliness, be user-friendly, and enable transparent connection and interoperation with other services and friendly forces. Special task areas for innovative research include methods and techniques that: a) enhance throughput, streamline interfaces to global communications assets and advanced radio architectures, and increase modularity, programmability, security (including LPI/D and AJ techniques), commonality and compatibility throughout various military and civil services and across the frequency spectrum; b) through signal detection, waveform recognition, parameter estimation, passive surveillance and interference excision, enable radios to sense and dynamically adapt to the signal environment to optimize performance; c) exploit adaptive rate speech compression techniques to adaptively manage the simultaneous transmission of secure voice and data over fixed narrowband channels for survivable communications networks; d) provide efficient means to couple wideband transceivers to either a singular wideband antenna, or multiple single-band antennas, that cover the range of 2 MHz to 2 GHz, are low-loss, small-size, and capable of supporting instantaneously, wideband spread spectrum, and fast-hopped waveforms; e) enable radio operators, via flexible, user-friendly Man Machine Interfaces (MMI), to quickly and efficiently manipulate functions within integrated communications assets, with minimal errors and training. Virtual control panels or pull-down trees are avenues for consideration and comparison.

Phase I: Identify techniques, explore algorithms, design interfaces, analyze and define designs for task areas a-e above. Provide comparison and simulation support for design decisions and detail trade-offs. Supply test and analysis data.

Phase II: Develop and demonstrate improvements attained through the application of Phase I concepts, techniques, and designs.

Dual Use Commercialization Potential: The commercial sector is urgently in need of secure, reliable, and flexible communications which are free of benign interference and noise. Advanced communications techniques such

as spread spectrum, LPI/D, interference excision, waveform recognition, etc., perform as well to counter noise, interference, spectral congestion, and other civil communications difficulties. Innovations in multi-band antennas and couplers, wideband transceivers, and MMT techniques are also transferable to the commercial user. Newly developed Frequency Domain Speech Compression techniques provide flexibility, security and high quality speech reproduction. Conversely, commercial communications developments will be exploited extensively for military use. Programmable and flexible interfaces between military radio equipment and commercial networks will enlarge dual-use potential.

AF94-061TITLE:High Temperature Superconductive Components for Multi-media Communications

CATEGORY: Basic Research

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop low loss microwave and high speed digital superconductive electronic components.

DESCRIPTION: Recent accomplishments in superconductivity invite new advances in communications technology. Applications will enable a significant increase in data throughput capability, while at the same time lowering cost, power and weight requirements. Innovative research for the applications of superconductivity include but are not limited to monolithic EHF transmit and receive phased-array antennas, data processing, and switching terminal applications. Examples of components needed include oscillators, mixers, filters, isolators, circulators and antenna feed structures. Research to develop superconductive digital technology such as A/D converters, shift registers, signal processing and data switching circuits are desired. Electronically variable ways to control amplitude, phase, or time delay in electrically large, wideband phased arrays are of interest. Innovative, monolithic, phased-array elements are needed which are compatible with thin-film superconducting feeds, and efficient radiators that provide thermal isolation of the superconducting feed circuits from ambient free-space temperatures. Where possible high-temperature superconductive digital and high power analog circuits are required. For this it is necessary to develop high-temperature weak link structures and thin-films capable of handling high power, i.e., 1.0 KW. The development of a practical technique for making a large number of reproducible junctions from high-temperature superconducting films, and the fabrication of logic circuits and shift registers using these junctions is necessary.

Phase I: The contract should analyze the theoretical background, and perform preliminary experiments to clearly demonstrate the technical feasibility of the proposed concept.

Phase II: The contract will require the development, test, analysis and conclusive proof by prototype demonstration of the component. Specific plans for transitional to Phase III will be detailed.

Dual Use Commercialization Potential: The civilian need for EHF communications and data highway technology eventually will grow as fast in the civilian sector as it is currently expanding in the DoD. Among many civilian applications are geosynchronous and low-earth orbit communications satellites capable of handling multigigabit data streams; commercial conformal antenna arrays and terminals on aircraft for crew and passenger data links via satellite to ground; conformal antennas and terminals on automobiles and trucks for navigation, communication and avoidance radar applications on the "smart" highway of the future; and commercial and residential antennas and terminals for data highway applications.

AF94-062TITLE:Multifunction Conformal Antennas

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop affordable array antenna technology for future air vehicles.

DESCRIPTION: Military, commercial, and private air, ground and sea vehicles of the future will require sophisticated but affordable antennas. Diverse requirements in areas such as video, voice, data and fax links, GPS connectivity, surveillance and collision avoidance radar, emergency communications, and multi- gigabit per second digital connections. Performance requirements will vary from high gain, multi-element arrays to low gain, multiple function single elements with broad spatial coverage. Sensor systems will operate in narrow bands or in multiple bands within the full microwave spectrum. Recent developments in digital array beamforming, adaptive control and neural networks show promise of leading to far more flexible and ultimately less expensive sensors for commercial as well as military systems. These new capabilities include smart control for array antennas that can sense failures and correct or compensate antenna patterns, super-resolution and neural network techniques that can perform accurate direction finding with smaller systems using less accurate, lower cost components. Automatic system calibration based upon the use of available beacons in the case of mobile collision avoidance, and adaptive cancellation of interference for mobile satellite terminals. These capabilities allow the use of small, low cost radar and communication sensors with increased capability due to the flexibility of digital adaptive and smart control. Since most of this flexibility will be implemented by and under computer control, the development of low-cost, digital beamformer modules containing all components from radiating element to analog to digital converter is key to this initiative.

Phase I: The contract should target a specific antenna application, refine the concept by a thorough theoretical analysis, trade study and error analysis, and perform preliminary experiments on key subsystems that will test the overall idea.

Phase II: The contract should demonstrate the full r-f performance expected by a prototype operating in a realistic environment, and deliver a component, subsystem, or full system implementation so as to attract Phase III venture capital with a working prototype.

Dual Use Commercialization Potential: An expanding commercial use of high technology products will include radar and communication capabilities for a variety of portable and mobile systems. Included are mobile links to Global Positioning Satellites, manpack and vehicle mounted satellite links, collision and high data rate links for voice, video, data and fax. These systems will face increasing demands for improved performance while maintaining pressure to continually lower cost.

AF94-063TITLE:In-Line Real Time Wafer Level Monitoring Techniques

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop advanced integrated circuit wafer-level in-line real-time techniques for monitoring integrated circuit reliability, thereby decreasing overall manufacturing costs and increasing the reliability of fielded systems.

DESCRIPTION: Most integrated circuit reliability testing is performed on a post fabrication basis. Therefore, a reactive response is required should the data show problems exist. Testing performed this way increases manufacturing costs through greater quantities of scrap, material usage and employee time. Also, not only is the wafer lot, which tested positive for the problem affected, but everything in production since then will be subject to the same problem. By moving to an in-line real-time monitoring system, manufacturer's will realize a cost reduction by positioning themselves for proactive solutions before multiple product lots are affected. This will necessitate changes in the parameters measured, as they will now be geared to the parameters (i.e., temperature, time, air purity, etc.) creating the material (i.e., oxide, metal, etc.) affected by the failure mechanism (i.e., oxide breakdown, hot carrier degradation, electromigration, etc.) and not the failure mechanism directly.

Phase I: Phase I will research process parameters suitable for monitoring reliability failure mechanisms and propose monitoring techniques.

Phase II: Phase II will implement the monitoring techniques and demonstrate the improved reliability of the process.

Dual Use Commercialization Potential: In-line monitoring techniques are applicable to all commercial integrated circuit production lines to assure manufacturability and cost competitiveness.

AF94-064TITLE:Low Cost Dual Use Environmental Measurement Device (EMD)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Build a small, reliable, low cost EMD using off-the-shelf components.

DESCRIPTION: An EMD will be designed and built using innovative environmental sensors. The design shall emphasize low cost, reliability, small size, and low weight. The module would be tailored to broad general use within government and industry for applications such as weather data collection, monitoring transportation of equipment, warranty verification, and operational environment determination. The EMD, capable of performing a 30 days operation shall weigh less than 20 lbs. Data will be obtained for the device using the RS-232 based computer. Research into methods for debriefing by modem from an ac line shall also be preformed.

Phase I: Complete plans, sufficient for construction or repair, and a prototype, adequate for test and evaluation will be supplied.

Phase II: Prototype units will be developed for subsequent test and evaluation.

Dual Use Commercialization Potential: Environmental measurement devices are applicable to the automotive, airline and ground transportation industries for monitoring failure causing hazards. They also are needed for the machine tool manufacturing industry as well as any automated production line.

AF94-065TITLE:Tools for Reliable and Manufacturable VLSI Microcircuits

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Development of methods and software tools for the optimization of gate level VLSI designs based upon reliability, speed, power, and area.

DESCRIPTION: Present methods for optimizing designs of VLSI circuits are based on VHDL gate level descriptions and employ a trade-off of speed with power or area or both. Reliability is not considered; but is important because of the need to shorten the time from concept to delivery, and to help assure that the delivered circuit does not contain a reliability time bomb. Reliability in this context means susceptibility to end of life failure mechanisms such as electromigration, hot electron degradation and/or short term reliability considerations such as ground bounce, voltage drop in power buses or latchup. This effort would develop methods and software tools for optimizing designs based on the reliability impact of the design implementation (fan-out of gates; functional implementation; power bus widths; and circuit application in the case of ASICs) and the trade-offs of reliability with speed, power and area.

Phase I: Define an approach and outline the methods for the optimization.

Phase II: Fully develop the methods and implement them in software tools; evaluating the tools against design test cases.

Dual Use Commercialization Potential: The software tools are critical for developing high reliability medical electronics (pacemakers/health monitoring systems) and safety related technology (automotive and aircraft control electronics).

AF94-066TITLE:Visualization Techniques for Computational Electromagnetics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Develop innovative uses of graphics workstations to assist the interactive analysis and design of electromagnetic radiating and scattering systems using a variety of computational electromagnetics tools.

DESCRIPTION: A variety of computational electromagnetic analysis programs exist for the design of large antennas and scattering systems and to analyze their interaction with the environment and electronics. The simultaneous, interactive use of these programs is becoming possible. Also, computer graphics work stations permit the analysis of large scale, optically illuminated scenes and the workstations permit interactive viewing of the scenes with a variety of illuminations and reflecting and refracting surface textures. The use of these same graphics work stations to analyze electromagnetic systems with monochromatic, coherent illumination has been demonstrated (IEEE Antennas and Propagation Magazine, April 1993). This work will explore the marriage of graphics work stations and large scale computational electromagnetic analysis programs to permit more effective computer aided analysis of large, complex antenna and scattering systems. Emphasis should be placed on techniques to permit the design engineer to visualize the mechanical and material properties of the structure or sub-structure being analyzed, visualize the large mass of technical data developed to assess design trends and to focus on effective modeling and analyses of sub-structures in the context of the larger design problem. Methods to verify and validate the design results with novel measurement and analysis techniques will be considered also.

Phase I: Identify innovative concepts which can be applied to increase the efficiency, effectiveness and applicability of current computational electromagnetic tools by the use of graphics work stations. Demonstrate the engineering design advantages by creating software to analyze one, limited class of important problems. Analytically estimate the advantages for an extended class of design problems.

Phase II: Develop, document and demonstrate an interactive, computational electromagnetic design program for an extended class of problems. Conduct preliminary testing of the design program to include limited testing and commentary with design engineers and experimental confirmation of the accuracy of the design data. The potential exists for joint testing with the Rome Laboratory using Government design engineers and measurement facilities.

Dual Use Commercialization Potential: Visualization tools are key for effective computer aided design and manufacturing of large antennas and the analysis of electromagnetic interference and compatibility problems in future, high data rate communications systems. Also, the tools developed will be useful in the education of engineers, and in the design of medical imaging systems, non destructive testing of large structures, and in the analysis of electromagnetic interference effects on airplanes and automobiles.

AF94-067TITLE:High Reliability and Efficiency Microwave Solid State Power Generation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Eliminate the diffusion-related gain degradation problem present in microwave power heterojunction bipolar transistors (HBT).

DESCRIPTION: For microwave power generation, HBT technology is emerging as a potentially cost-effective alternative to the metal-semiconductor field-effect transistor (MESFET)-based technology, as it requires only one power supply instead of two. Although digital HBTs are meeting today's specifications, the viable use of high power HBTs has been diminished by reliability problems. These devices, with the current state-of-the-art fabrication technology, are plagued by thermal problems, caused by diffusion of dopant from the p-type layer at high temperatures. A new low-temperature molecular beam epitaxy (MBE) growth method is needed to grow highly doped (5.0 E +19 cm^-3) epitaxial layers to assure a very sharp p-n junction with no diffusion. These devices must have a forward DC

characteristic with low offset voltage and very sharp turn-on compared to FETs in order to achieve high current gain and high RF output power. Novel approaches to producing high current gain, high reliability, high performance, and high power HBTs will be considered. Fabrication of simple test structures will be required for conducting accelerated stress life tests in order to verify that the new technology is capable of producing high reliability devices.

Phase I: Investigate possible approaches, selecting one or more candidate approaches. Design new product devices based on selected approach.

Phase II: Fabricate new product devices and test structures using selected approach and carry out long-term accelerated life test followed by detailed failure analysis.

Dual Use Commercialization Potential: Microwave communication devices exemplify dual military/commercial uses because the same technology used to make solid state radar can be commercialized for satellite communication via cellular phones.

AF94-068TITLE:Integrated Diagnostics for Multi-Chip Modules (MCM) Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop/Verify Built-in-Test (BIT) Techniques to assure cost effective/comprehensive methodologies for performing diagnostics for MCM and DOD/Industry applications.

DESCRIPTION: Integrated testability diagnostic technologies are a critical elements for improving the support capability of AF weapon systems. The ability to design testability into a system and exploit the BIT as an integral part of the diagnostic process must be establish via a chip through system diagnostic approach. This technical capability will provide logistics organizations with a significantly improved maintenance capability in recognition of the consequences of reductions in force structure and resources. Technology needs exist in both the development of new diagnostic technology and the integration of existing tools and techniques for diagnostics. Chip-Through-System testability techniques need to be established to integrate test and diagnosis vertically by considering the top-down allocation and bottom-up implementation of system wide testability. This integrated chip-to-system approach for testable and diagnosable design must address all levels of system indenture. MCM design and analysis techniques for testability must be established to link the BIT capability developed for the MCM with the system level diagnostic strategy. Efficient and effective diagnosis for faulty electronics requires elaborate BIT techniques be developed within the MCM and be assessable by any diagnostic subsystem performing a verification of functional status. This MCM diagnostics technology will provide a systematic process for design, test, and verification techniques and, in turn, a more productive and cost effective diagnostic and maintenance capability.

Phase I: This effort will develop built in test approaches for MCMs which will satisfy specific DOD and commercial requirements.

Phase II: This effort will use the developed built-in-test approaches to prove effectiveness and cost savings associated with these approaches as well as demonstrate the diagnostic capabilities on both a commercial and DOD application.

Dual Use Commercialization Potential: With the ever increasing push to add more capability into smaller, lighter weight applications, research into multichip modules has seen a significant increase in interest by both the DOD and industry. Cost to test these complex devices has become a technology roadblock to transition MCM technologies into the market place. This effort will reduce test times and cost as well as increase the diagnostic capabilities of these devices in system applications.

AF94-069TITLE:Applications of Ultra-Thin Semiconductors in Space Systems

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop and demonstrate techniques for thinning "as-built" wafers and/or separated integrated circuit devices to hyper-thin dimensions (<25 microns).

DESCRIPTION: Techniques must be developed and demonstrated in a manner which allows their subsequent packaging and reliable operation in space environments. The expected benefits of this technology are that the density, thermal transport, and radiation performance of semiconductor devices will be improved. This technology provides a complementary alternative to other existing and contemplated approaches which provide these enhancements. Furthermore, other radical, intriguing possibilities exist. For example, it may be possible to implement the design of conformable electronic systems that need not be affixed to planar substrates. Rather, it is conceivable that electronics subsystems and components could be mounted on curved or perhaps other irregular surfaces, such as those found in the interior of a missile or spacecraft. It is currently common practice in the Japanese semiconductor industry to backgrind memory components for inclusion in the class of chip carriers known as thin, small outline packages (TSOPs). The motivation for this approach is to improve the density and thermal dissipation characteristics of memory components. As such, portable computer systems can easily accommodate dozens of memory components within their small physical form factors. The dimensional range for these thinning operations roughly spans 7-10 mill-inches (up to 250 microns). Thinning silicon and other semiconductors to well below these dimensions (<<5 mill-inches or 125 microns) opens an intriguing if not challenging realm, hereafter referred to as "hyper-thinning." Of course, with hyper-thinned silicon, additional density is gained and thermal transport is improved since the heat produced by the component has a shorter exit path. Beyond the obvious, however, are new possibilities which have been postulated but remain to be adequately understood. For example, hyper-thin silicon loses its brittleness, and it has been indicated that components prepared in this manner might even be conformable to a wide variety of irregular surfaces. Additionally, some speculate that hyper-thinning certain silicon circuits might improve their radiation performance. In other cases, it has been suggested that stacks of sensitive, hyper-thinned wafers (set apart by less than 50 microns) might constitute a superior new form of a particle detection system. Innovative applications of silicon in the hyper-thin regime to space systems are sought.

Phase I: Proposals should explore in depth the appropriate treatment procedures of a candidate semiconductor process for hyper-thinning. Teaming with established, spacegrade microcircuit manufacturers is encouraged in order to access superior baseline process technologies. The basis for a suitable application complementary with the hyperthinning technology must be thoroughly evaluated.

Phase II: A typical Phase II program would implement reliability investigations of the hyperthinned components along with the development of a demonstration application. A successful phase II program would bridge the thinned component process technology and/or the candidate application into other applications.

Dual Use Commercialization Potential: Although the technology will enable military requirements, the importance of establishing an infrastructure for availability through commercial catalyst applications can not be overemphasized. The basis for suitable military and merchant application complimentary with the hyperthinning technology must be thoroughly evaluated and established to define demonstratable Phase II applications.

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AF94-070TITLE:Applications of Micro-Machining Technology in Space Systems

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop and demonstrate micromachinging techniques applied to advanced microelectronics packaging and other space-critical technology areas.

DESCRIPTION: New advances in the fields of micromachining are expected to provide enabling benefits in the capability of space systems. Among the many problems faced by space systems are the need for improved thermal management, sensor integration, and embedded electronically-activated actuator assemblies. Micromachining technologies, especially those pertaining to silicon, have evolved over the last several decades. Micromachined features and components offer extraordinary efficiencies in their functional domain as compared to similar "macromachined" equivalents, alleviating extra bulk, structural interfaces, and cooling/heating requirements. While many intriguing and promising developments have been reported, some of the most salient micromachining concepts are still considered lab curios. For example, in advanced packaging, micro-channel cooling technologies, with tremendous heat removal capacity, are well-known in the literature and simple to replicate in the laboratory, but they have not been transitioned into applications that could benefit from them. Innovative improved advanced packaging technologies through the development, insertion, and demonstration of novel micromachining concepts are sought.

Phase I: Phase I proposals will address practical techniques to improve particular aspects of space system design and fabrication. Technologies that allow enabling, systematic reductions in size, weight and power while maintaining or improving performance and reliability are of keen interest. The categories for improvements include (but are not limited to): advanced packaging, improved thermal management, micro-encapsulated cryogenic coolers (for infrared focal plane arrays and detectors), positive component securing techniques, embedded micro-mechanical relays, micro-mechanical solenoids, and inertial referencing components (accelerometers, gyroscopes). Practical technology insertion must be addressed, particularly noting: 1) the space environmental context of prospective applications, which will drive reliability and ruggedness, and 2) the tremendous potential for cost reduction, establishment of manufacturing infrastructure, and enhancement of domestic competitiveness through commercialization of these technologies.

Phase II: Demonstrate the repeatable, quality formation of components. Cooperation and leveraging one or more already existing multi-chip module (MCM) technologies is highly encouraged, as it is not the desire or intent of this topic to invent a new MCM approach.

Dual Use Commercialization Potential: The results of a successful Phase II approach would lead to superior micromachined applications that could be inserted in space-based and other military and commercial applications.

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AF94-071TITLE:Component Enhancement of AMTEC Devices

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop components which enhance the performance, reliability, lifetime, and cost of AMTEC devices.

DESCRIPTION: AMTEC (Alkali Metal Thermal to Electric Conversion) is a relatively new energy conversion concept, related to the sodium-sulfur battery, which, when used with a solar thermal or nuclear heat source, could provide efficient, low mass, low cost, high reliability, long-lived power systems for Air Force satellites. This topic seeks innovative component technologies to further improve the life, reliability, performance, and cost of AMTEC power systems.

Phase I: The contractor shall identify such technologies and determine their usefulness to meeting the solicitation goals when incorporated into a power system. The contractor shall also formulate a development and testing plan for integrating the technology(ies) into an AMTEC cell.

Phase II: The contractor shall construct one or more AMTEC cells incorporating the innovative components and test them to determine their overall utility. The contractor shall also assess the applicability of these components to other energy conversion systems.

Dual Use Commercialization Potential: The components could be further developed to meet the specifications for a particular application, including adaptation to meet the requirements of a sodium-sulfur battery. Potential applications of the power conversion technology developed by this effort include primary and secondary space and terrestrial power systems. Specific potential commercial applications include serving as the thermal to electric conversion device in an external combustion/battery/electric motor automobile power plant, cogeneration of electricity from process heat, and self-powered, high efficiency water heaters.

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AF94-072TITLE:High Temperature, Radiation Resistant Power Management And Distribution Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Energy Storage

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop high temperature, radiation resistant power management and distribution technologies for space reactor power systems.

DESCRIPTION: Space nuclear reactor power systems typically generate high currents and have long separation booms requiring long power cables. The combination leads to large resistive losses in the power transmission system, which imply that an efficient, low mass power management device could provide significant mass savings for the power system. To be most effective, the power management device needs to be as close to the reactor power source as

possible, but the high temperature, high radiation environment causes problems for most power management technologies.

Phase I: The contractor shall develop the conceptual design of one or more fault tolerant, high temperature, radiation resistant power management systems designed to handle 5,000 watts (electric). For each candidate power management system in Phase I, the contractor shall identify electrical characteristics, materials of construction, interface requirements, development status, life limiting machanisms, scaling implications (to 50 kWe units) of the technology, the level of modularity of the system, and key enabling technologies of the system.

Phase II: The contractor shall develop a working prototype of the converter as a proof-of-principle device. In addition, the contractor shall investigate systems to determine the performance of the technology in comparison with established power management systems.

Dual Use Commercialization Potential: The prototype could be further developed to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost, and manufacturability. Potential applications of the power management technology developed by this effort include primary and secondary space and terrestrial power systems.

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AF94-073TITLE:On Chip Temperature Sensor

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop, design, and fabricate an on chip temperature for a hybrid array.

DESCRIPTION: Ideally, in the first phase a sensor capable of monitoring and determining the temperature of a hybrid operating from 300 to 9K will be developed and researched. The sensor should be compact and easily integrated into existing hybrid designs involving HgCdTe or Si: As detector and silicon readout technologies. The sensor can be placed on the detector or on the readout. The sensor must not interfere with the hybrid's detecting abilities or cause extensive noise. A prototype sensor at the scale of present hybrid technology and in the material used for either the detector or readout will be fabricated and tested. In the second phase of this project, the resulting temperature sensor design will be incorporated into a hybrid design which will be fabricated and tested to determine the sensor's capabilities. A variety of hybrids will be charaterized to determine the reliability of the device and the effects on the hybrid's operability.

Phase I: To proceed to Phase II, critical design aspects must be met. The design of a temperature sensor must be successfully incorporated into the particular material without serious material defects. The resulting test data from the prototype must be proven to work at the required temperatures, and at the scale required for integration into existing

hybrid technology.

Phase II: Success of Phase II will hinder on successful integration of the sensor to an existing hybrid design. The design will the be inserted into a processing line and various hybrids fabricated and tested to determine reliability and producibility.

Dual Use Commercialization Potential: Hybrid arrays are used for cameras in medical, astronomical, and environmental uses. The technology has potential for being integrated into these arrays or the processing lines used to fabricated them.

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AF94-074TITLE:Integral Bilateral Electronic Components Technology for Spaceworthy Multi-Chip Modules

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop techniques that allow bilateral, passive components (e.g., resistors, capacitors, inductors, transformers) to be realized in multi-chip module technologies.

DESCRIPTION: Passive electrical components are a part of every electronics assembly. While great strides have been made in massive integration of active components (e.g., transistors, diodes) into integrated circuits, passive components are often attached discretely to the next level of assembly, whether a hybrid, multi-chip module (MCM), or printed wiring board. Specialized, low-profile resistor and capacitor components have been traditionally employed in hybrids and MCMs. However, these components and the labor associated with inserting them into an MCM is significant. Even in highly automated assembly operations, the expense of inserting passive components is greater than that of the components themselves. This problem will be exacerbated as more designs migrate from discret analog and mixed signal assemblies to MCM form, which require many more passive components than the digital designs that currently comprise over 95 percent of all MCM applications today. By incorporating the components into the fabrication process directly, the expense of procuring, screening, and assembling dozens of components is practically eliminated. The net benefit to space systems is a reduction in size, weight, power, and cost, with a collateral benefit in improved performance, particularly in mixed signal systems which often require complex networks of these components. Furthermore, integral components will provide for a greater overall substrate efficiency, resulting in smaller, more efficient, and more reliable MCMs. Innovative solutions to improve MCM technologies through the development and demonstration of integral passive components are sought.

Phase I: Phase I proposals will address techniques to form these components within the interconnection system itself. Alternately, but less desirable are those approaches that depend on a particular type of substrate. Component electrical quality is of primary concern, as is the ability to closely and repeatably form these components to a degree of precision adequate for analog instrumentation and signal processing applications. Preferably, this solution would be applicable and transferable to high performance polymeric-based MCM technologies. This approach is preferred over the development of a new, unique MCM technology, in light of the significant existing base of these technologies.

Phase II: Phase II would demonstrate the repeatable, quality formation of components. Leveraging against one or more already existing MCM technologies is highly encouraged, as it is not the desire of this solicitation to invent a new MCM approach. The results of a successful Phase II approach would lead to a superior integrated passive circuit technology that could be transferred to a number of candidate MCM approaches.

Dual Use Commercialization Potential: The results of a successful Phase II approach would lead to a superior integrated passive circuit technology that could be transferred to a number of candidate MCM approaches, both military and commercial.

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AF94-075TITLE:Innovative Small Space Power Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Energy Storage

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop innovative, low cost, reliable, low mass, long life 500 watt satellite power systems.

DESCRIPTION: As part of the drive to reduce defense costs, most system program offices are reducing the cost and size of their satellites while striving to maintain mission performance, lifetime, and reliability. Similar trends are seen in NASA and commercial satellites. Since the electrical power systems is roughly a third of the mass and a tenth of the cost of a satellite, one good way of supporting this trend is to provide smaller, cheaper power systems. The challenge for the innovator is to combine performance, reliability, durability, and affordability into one system at acceptable risk.

Phase I: In Phase I, the contractor shall produce the conceptual design of one or more power systems and identify thermodynamic characteristics, materials of construction, interface requirements, development status, life limiting mechanisms.

Phase II: In Phase II, the contractor shall develop a working prototype of the system (possible subscale) as a proof-of-principle device. In addition, the contractor shall perform system studies to determine the performance of the technology in comparison with established space power systems.

Dual Use Commercialization Potential: In Phase III, the prototype could be further developed to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost and manufacturability. Potential applications of the power system and associated technologies developed by this effort include DoD, NASA, and commercial satellites, as primary and secondary power sources, and terrestrial power systems, including cogeneration applications. Specific potential commercial applications include a follow-on to the proposed Irridium communications satellite constellation and serving as the power plant for remote vehicles such as mine rescue robots. In view of the general trend toward smaller satellites, the potential market for a successful small power system is quite large.

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AF94-076TITLE:Military Networks Fast Packet Satellite Switches

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Create a smooth infusion of fast packet switching technology by developing a compatable space and communication link.

DESCRIPTION: The future of communications is migrating towards fast packet switching technology (e.g.,Broadband Integrated Services Digital Network). This migration is seen in both the efforts of the commercial world and the Department of Defense (DOD) efforts to combine all the military area networks. The result of this technology will be increased bandwidth (155Mbps to 2.3 Gpbs) and many services that are not presently available in military networks. The development of the current military communications technology is only expected to increase the space communication link data transmission rate capacity from its current rate capacity of 10Mbps to 20Mbps. In order to take full advantage of the fast packet switching technology's data transmission rate capacity, the space communications link will also have to migrate towards a compatable technology. The space communications link would infuse developing fast packet satellite switches, such as the switches under research and development at COMSAT laboratories. The impacts to military communications would be communications system that would supply the military's communications needs, services, and quality of service (QOS) guarantees for any far term requirements.

Phase I: Research and identify the current developments of fast packet satellite switches in the commercial world. Next, research and identify military communications development and design requirements that must be applied to fast packet satellite switch technology development. This phase will conclude with the design of a fast packet satellite switch that will be compatible with future fast packet switching technology infusion.

Phase II: Based on the Phase I design, physically develop a fast packet satellite switch that meets and exceeds current military requirements. The military fast packet satellite switch will be deliverable upon completion of the Phase II technical efforts. This developed technology has a direct impact on the smooth infusion of fast packet switching technology into the military communications segment.

Dual Use Commercialization Potential: The introduction of public networks, such as the Asynchronous Transfer Mode (ATM) networks that will be offered by regional Bell operating companies by 1994, has increased the need to develop fast packet satellite switches in the commercial world. The need to offer these networks and their associated network services over the continental United States and eventually the World will be the main driver for the development of these satellite switches. Of course, a more general but critical commercial application wil be fast packet switching satellite communications.

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AF94-077TITLE:Multimedia In Space Systems Operations

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop a prototype system depicting how space operations would be conducted utilizing multimedia technology.

DESCRIPTION: Currently space operations uses various computer systems with different operating systems, software, training, hardware, configurations, and skills required to operate in a command and control environment. Multimedia technology proposes that with an environment that has the potential to display multiple data sources simultaneously, process real-time data, voice and video, operations can be conducted from one or multiple generic multimedia stations located throughout the network. The research will delve into what technologies are needed to arrive at or meet operational requirements in a space systems environment. It will also address what capabilities will be derived from multimedia and what possible scenarios would evolve from this environment. The research will also describe what benefits or limits are placed on space operations by introducing multimedia into a command and control environment. The integration of multimedia into space operations would facilitate the network's ability to meet its goals in terms of a reduction in personnel and skill levels for conducting operations.

Phase I: Assess current technologies, determining the status of multimedia as it is presented today. Define what evolution is taking place with multimedia and what technologies will play a role in how multimedia will mature in the future. Develop a multimedia environment implementation plan which conceptually defines how AFSCN operations would be conducted and contains a preliminary prototype design.

Phase II: Develop a prototype system that depicts a concept of how operations will be performed in a multimedia environment. Define the software and hardware requirements, costs, risks and feasibility involved in implementing multimedia a Command and Control environment.

Dual Use Commercialization Potential: Multimedia has numerous commercial applications. Uses of the technology derived from this research include: educational applications for geographically constrained students, home voting, real-time surveying, worker and student training or retraining, government agencies information services, and a number of law enforcement applications such as real-time video identification and/or interactive uses.

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AF94-078TITLE:Space Systems Technology Development

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Innovative developments for improving performance, endurance and survivability of future advanced space and missile systems.

DESCRIPTION: Advanced space systems need a host of integrated technology developments in order to meet improved performance requirements. We are seeking innovative approaches and technology developments which will provide improved space system performance, endurance and survivability. The proposed approaches should emphasize "dual use technologies" that clearly will have private sector as well as military applications. Some dual use examples include High Definition Television (HDTV), advanced communications, energy, and environmental conservation technologies plus many more. Specific area of interest include:

PASSIVE SENSORS: Required are innovative approaches for developing ultraviolet to very long wavelength infrared detectors, readouts, focal planes, and sensors. Innovative concepts dealing with multi-spectral sensors and passive microwave sounder are needed. Also needed is data fusion, simulation, and integration for improved sensor design and performance.

ACTIVE SENSORS: Innovative approaches in active sensor concepts including LIDAR, RADAR and associated signal processing, signal conditioning, plus related devices and subsystems are needed.

SPACE COMMUNICATIONS: Needed are advanced concepts in space systems communication electronics and developments in antennas, devices and processing for RF, and laser inter-satellite links, plus TT&C systems.

SPACE POWER SYSTEMS: Innovative approaches that will lead to higher specific power at lower cost are needed. Specifically, long life, high energy density batteries, advanced solar cell designs, light weight solar arrays, and power control electronics.

CRYOCOOLERS: We need innovative concepts that will improve the efficiency,reliability and performance of existing designs.

SPACE ELECTRONICS: Innovative approaches in design and development of advanced processors, memory, ASICS and other electronic devices, packaging technology, micro-electro-machines, and micro-electro mechanical devices are desired. Also required are insulated devices and cryogenic electronics.

SPACE SYSTEMS SOFTWARE and SIMULATION: Advanced concepts in reusable software, spacecraft autonomy and spacecraft control and scheduling are needed. Object oriented programming for interactive simulations, hardware in the loop simulation tools, neural networks for enhanced signal, data processing and sensor fusion techniques are needed. Also desired are advanced orbital dynamics and on-orbit simulation tools.

SPACE STRUCTURES: Innovative minimum weight structural concepts are needed that can withstand high-G space launch and ambient environment effects. Active and passive vibration suppression, control, advanced material

applications, designs and analysis methods are needed.

Phase I: Develop the concept and perform the necessary analysis required in order to select the promising approach. Develop preliminary plans, designs and possible laboratory scale demonstration.

Phase II: Complete the Phase I designs and develop a demonstrator or prototype. All hardware and software developed under both phases shall be delivered to the Phillips Laboratory upon completion of the Phase II effort. Document the R&D and develop a technology transition and insertion plan for future systems and commercial ventures.

Dual Use Commercialization Potential: Space systems for DoD and commercial use require advanced technology that is highly reliable, high performance, and is survivable to a variety of man made and natural environments. These technologies have immediate and definite commercialization potential in consumer goods and infrastructure improvements such as highway safety, environmental monitoring, etc.

AF94-079TITLE:Built-In-Test for Electromagnetic Shielding

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a built-in diagnostic test system for monitoring electromagnetic shielding of aircraft cables and electronics enclosure.

DESCRIPTION: Military aircraft make extensive use of shielded cables and enclosures to protect sensitive electronics from electromagnetic induced transients. The electromagnetic environments encountered by these aircraft range from normal operating environments created by radios and radars to war time threats such as nuclear Electromagnetic Pulse (EMP), High Power Microwave (HPM), Ultra Wide Band (UWB), and other advanced electromagnetic threats. To maintain the shielding properties of these cables and enclosures, periodic testing is required. These tests are time consuming, resource intensive, and cause the aircraft to be out of service for extended periods of time. Increases in normal electromagnetic environments, advances in electromagnetic weapons, and increased use of low power, high speed electronics place a greater demand on the maintenance of cable and enclosure shielding. Studies and experiments have demonstrated that electromagnetic radiated white noise, at levels at or below the ambient electromagnetic noise level, can be used to measure the transfer functions of shielded cables and enclosures. Using stochastic correlaiton techniques, the measured signals within the shielded systems can be statistically correlated to the external radiated electromagnetic white noise. It has also been demonstrated, in a limited case, that non-white or "colored" noise can also be used for the same purpose. Military combat aircraft generate a colored electromagnetic noise environment which should be sufficient to allow on-board monitoring of shielded systems. Miniature current and voltage sensors mounted within shielded enclosures to measure the noise present on wires combined with sensors to measure the external electromagnetic noise would provide the necessary data to monitor the shielding. It may also be possible to eliminate the need for the real time external measurements and rely on one time measurements and statistical approaches. The use of stochastic, fuzzy logic, or other techniques to correlate the external and internal measurements would then allow unacceptable degradations in the shielding to be logged to a central computer for correction during routine maintenance activities.

Phase I: The Phase I effort will develop preliminary hardware and demonstrate technical feasibility of a real time shielding monitoring system for shielded cables and enclosures.

Phase II: In Phase II, the contractor will develop a working model of an actual monitoring system with sensors and microcircuit electronics integrated into an existing avionics subsystem installed on one of the Phillips Laboratory's testbed aircraft.

Dual Use Commercialization Potential: Commercial aircraft and other systems, such as high speed bullet trains, computer-controlled manufacturing systems, and communication systems, are exposed to hazardous electromagnetic environments. All these systems must be protected to these through electromagnetic shielding. They would benefit from this technology in terms of safe and reliable operaiton and reduced maintenance costs.

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AF94-080TITLE:Computer Model for GaAs Photoconductive Semiconductor Switch

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop an accurate computer model of a photoconductive semiconductor switch.

DESCRIPTION: The use of semiconductor wafers as a pulsed power RF switching device is a relatively new innovation. GaAs devices exhibit a non-linear mode of operation known as "lockon." This mode is achieved when the electric field across the device and the laser energy used to trigger the device are above a given threshold. Approximate threshold values can and have been established for laser energy and electric field for specific devices. In general, the laser energy required is inversely proporational to electric field strength provided the E-field is greater than 8KV/cm (the "lockon" field) across the device. The "lockon" phenomenon is not well understood or defined. Development of an accurate computer model for this switching device may entail determining the major material variables, contact attachment processes, and geometrical properties (switch and contact) that affect the electrical operating characteristics of this type of device. The effect of the laser trigger parameters (wavelength, energy temporal and spatial intensity profile) on the operation of the switch is also of concern. A computer model of a GaAs photoconductive semiconductor switch is desired to aid in the design and development of transmission line circuitry utilizing this device. The model should reasonably predict the switch closure time, "lockon" field level, and switch jitter for a given set of parameters. The ability to use this model with existing PC based circuit simulator computer software such as PSPICE is highly desirable.

Phase I: Phase I of this program is to determine the feasibility of creating an accurate circuit model based on material and process variables for two different switch geometries. Examples of variables to be defined for the material: mobility, resistivity, dopant concentrations, laser cross-section energy absorption, etc. Examples of process variables would include ion implant, contract fabricatin, annealing, metalization, epitaxy, etc. Experiments would be proposed to obtain the required information that is not currently available.

Phase II: Phase II of this program is to create the computer model. This includes all experiments necessary to characterize the various variables identified in Phase I. Sufficient copies (5) of this prototype software and document, user guidance, etc., must be delivered for government use.

Dual Use Commercialization Potential: PCSS devices have several potential commercial applications: e.g., radar, microwave, and power switching. Shipboard radar, microwave ovens and similar devices could utilize the PCSS as the microwave generation component since the power required is relatively low and within the ability of present devices. Power switching which currently uses SCR devices could use the PCSS device and in some applications the addition of electrical trigger isolation may be advantageous. These commercial applications would greatly benefit from the ability to model such devices for their particular planned usage. This SBIR, if successful, will provide industry such a model.

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AF94-081TITLE:High Power, Wideband, Transmission Line Geometry Converters

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Demonstrate innovative approaches and designs of efficient, low dispersion geometry converters for use in high power ultrawide bandwidth microwave generators.

DESCRIPTION: Wideband, high power microwave sources often deliver the majority of the energy in a mode (such as coaxial transverse electromagnetic, or TEM) which does not radiate in a desirable pattern. Conventional baluns (which can convert coaxial TEM (unbalanced) to parallel plate TEM (balanced)) do not possess the high-power, nondispersive characteristics that are required. Design of high gain systems for fast-risetime operation is impractical using traditional frequency domain techniques since these do not fully express the transient nature of the electromagnetic phenomena. Thus, the design of these converters must be approached in a fundamentally different way. Innovative techniques are required to design efficient hardware meeting the needs of the Air Force, including (but not limited to) the application of optics and the use of lenses, as well as recent developments in multiconductor transmission line techniques and composite ferrites.

Phase I: Phase I work shall identify and investigate new and innovative approaches to the design of efficient, high power, fast risetime, non-dispersive transmission line geometry converters. TEM geometries of interest include coaxial, planar, conical, as well as others. Phase I should include the design and construction of models (computational and/or actual), as well as measurement and evaluation of performance.

Phase II: Viable approaches identified and formulated in Phase I will be applied to the practical development and implementation of converters for high power, fast risetime applications. Phase II hardware shall be capable of handling at least millions of volts and hundreds of gigawatts of peak power and convert a coaxial TEM pulse possessing less than an 80 picosecond risetime into a planar TEM pulse while introducing no more than 15% risetime degradation or energy loss.

Dual Use Commercialization Potential: This technology is of interest to the private sector because it is essential for the transmission of wideband transient microwave energy. Applications include radars for mapping buried objects. This will provide enabling technology for use in identifying and characterizing old waste sites (i.e. locating buried waste drums and other hazards). Similar radars could also be used in airborne and terrestrial vehicles for collision avoidance.

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AF94-082TITLE:Wide Bandwidth Analog Fiber Optic Data Links

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop low cost, wide bandwidth analog fiber optic data links.

DESCRIPTION: Presently, wide bandwidth analog fiber optic data links for use in electromagnetically noisy environments are either unavailable or very expensive. A prototype analog fiber optic data link with the following characteristics will be developed and tested: (1) the 3dB bandwidth will be at least 500 MHz; (2) the power source will be self-contained, rechargeable, and capable of operating for 8 hours without recharging; (3) the data link will be immune to the electrical noise generated by the high energy pulsed power systems; and (4) the input impedance will be 50 ohms. This proposed investigation and development is unique due to the simultaneous requirements of a wide bandwidth, noise immunity, and low cost.

Phase I: The Phase I effort will be a feasibility study and design of a complete low cost, wide bandwidth analog fiber optic data link capable of low noise operation in a harsh electrical environment (multi-megajoule, several hundred terawatt pulsed power systems). The input to the data links will be fast, single event signal pulses ranging from a few millivolts to several tens of volts in amplitude. The transmitter portion of the link may be electrically connected to systems which rise several hundreds of kilovolts during the event. Therefore, the transmitter power source should be independent of the AC mains.

Phase II: In Phase II, the effort will involve the development and manufacture of operational fiber optic data link prototype system capable of being incorporated into existing data acquisition systems used on in a very noisy electromagnetically noisy environment.

Dual Use Commercialization Potential: This technology has a great potential for future commercialization. A manufacturable product as described above will be specifically of great benefit and use in any high speed communications systems such as national phone, data, TV, cable, etc. linkages. In addition, such technology will be applicable to anyone collecting test data where it is required to do so in an electromagnetically noisy environment.

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AF94-083TITLE: Advanced Weapons Source Development, Effects Measurements and Satellite Survivability Modeling

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Survivability and Hardening

OBJECTIVE: Develop advanced weapons concepts such as high power microwaves (HPM) and plasmas, and to produce new models of various threat conditions on satellites.

DESCRIPTION: The Phillips Laboratory (PL) is in need of new, innovative approaches in the development and demonstration of compact, light weight, microwave sources for potential weapons applications. The technology sought should address our requirements of gigawatt level power delivered in microsecond and shorter pulses. Both narrow band and wide band sources are of interest. The technical issues that may be addressed in this effort include the pulsed power, HPM tubes, transmission lines, converters, and antennas necessary to make such a technology feasible. In addition to source development, new concepts for the measurement of radio frequency (RF) effects of gigawatt pulses in the tens to hundreds of gigahertz frequencies. These measurement techniques must be relevant to conducting test programs of the coupling of this RF radiation into complex test objects without perturbing the testing conditions. PL also solicits innovative approaches towards further development of advanced weapons concepts in high density, high energy plasma production, measurement, and exploitation. Using the Shiva Star facility (a large capacitor bank capable of dumping 10 megajoules of energy in microsecond times) to create these plasmas, concepts are sought which will demonstrate substantial improvements over current capability in modeling of the physical processes involved, and measuring of the pertinent plasma properties. In addition, PL solicits new, innovative approaches to satellite survivability modeling. Modern US satellites are faced with many threats which have the potential to upset, degrade, or eliminate proper operation of its subsystems. These threats range from normally occurring actions such as thruster firings, space debris, and orbit-dependent chemical reactions with naturally occurring species. They also include hazards due to attack from nuclear, RF radiation, and lasers. New, innovative models are required which are capable of analyzing the fundamental processes which occur during such events, and perform assessments of the likely outcome of the event on the affected satellite. Special attention must be given to the ability of the model to be integrated into existing techniques, the ease of use of the model, and the time of execution, and the manipulation of created and existing databases.

Phase I: In the initial phase of this effort, a feasibility study will be conducted which identifies, through the process of analysis, the best approach from those chosen to solve the problem. A proposed schedule for implementing the chosen approach will be included in the final report.

Phase II: In Phase II, the selected approach from Phase I will be implemented, producing a prototype model and/or device which has been demonstrated to be effective either at full operation, or scaled to lab bench parameters. Any prototype computer model (and its associated documentation) delivered in Phase II, will be provided in sufficient number (5) for the government to conduct validation testing.

Dual Use Commercialization Potential: Many of the necessary technologies required for advanced weapons design have commercial applications. For example, the development of pulsed microwave source technology will be of potential benefit to ground and subsurface radar concepts, collision-avoidance radar systems, and to medical imaging technologies. Also, the weapons effects models developed for electromagnetic scattering of RF fields can be applied to commercial industry design of better protected systems to high intensity radiated fields.

AF94-084TITLE:Advanced Materials Applications for Liquid Rocket Engines

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Demonstrate advanced materials and processing tecnologies showing performance or cost improvements in liquid rocket engine components or systems.

DESCRIPTION: Innovative concepts for application of advanced materials to liquid rocket engines are being sought. New advanced material structures may decrease the weight of components such as nozzles, gas-generators/preburners, combustion chambers, housings, and ducts by 10-50%. New thermal barriers could eliminate or greatly reduce the need for convective cooling. Environmental barriers may permit conventional materials to operate at high temperatures, free from corrosion or embrittlement by propellant gases. New classes of high temperture materials could permit devices such as turbines to operate at much higher temperatures and top speeds, resulting in performance

improvements. New materials may also lead to innovative design approaches, accomplishing the same task, but in bold new ways.

Cryogenic rocket propulsion systems demand the lightest possible weight and highest possible performance from each of their component parts. Transportation, construction, and power generation equipment demand similar qualities of their components, however, the operating environments of liquid rocket engines are particularly harsh. Combustion chamber gases approach 6000 F in either reducing or oxidizing environments. Turbopump turbine inlet temperatures can exceed 1600 F, also in reducing or oxidizing environments, while requiring turbine top speeds in excess of 1600 ft/sec. Repeated starts induce extreme thermal shock and fatigue. Fuel pumps only feet away form these high temperature turbines operate near -420 F and discharge pressures can exceed 10,000 psi. Recent advances in materials technology can substantially increase liquid rocket engine performance by enabling higher temperature operation, lighter weight component structures, and significantly higher system reliability. Substantial propulsion improvements are required to assure low-cost access to space, global force projection and intelligence collection/targeting of strategic relocatable targets. Advanced materials technology can lead to such performance increases. These technologies can also be applied to such diverse commercial areas as civilian launch vehicles, high speed civil transports, electrical power generation systems, automobiles, and high temperature toxic waste disposal systems.

Phase I: The Phase I effort will consist of one or more of the following: material characterization in a simulated rocket engine environment, component fabrication demonstrations, or innovative component designs. Projected or demonstrated performance or weight improvements resulting from Phase I research will be the basis for selecting a Phase II effort.

Phase II: The Phase II effort will apply Phase I research through component development, test and evaluation, or detailed design and analysis. Deliverables will include one or more of the following: advanced material componenet(s), component test and evaluation results, andvanced materials database, or detailed innovative component or system design.

Dual Use Commercialization Potential: Historically, advanced materials and processing technologies developed for military aerospace use have had tremendous impacts in commercial industries. For example, carbon fibers developed for rocket nozzle applications have revolutionized bicycles, automobiles, sporting goods, and safety products. The technology developed through this research can be commercialized not only through the rocket propulsion industry but also through aircraft gas turbine, electrical power generation, and commercial transportation industries. The technology will be commercialized through the Liquid Rocket Propulsion industry. Advanced material components can be marketed through other high technology industries such as the aircraft and automotive industries.

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AF94-085TITLE:Innovative Spray Measurement Techniques for Rockets

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop improved spray measurement techniques for validating CFD codes in rocket engines.

DESCRIPTION: One of the requirements for meeting critical Air Force needs such as assured satellite communications or the ability to kill strategic relocatable targets is to have propulsion systems which guarantee rapid, reliable access to space. Many of these systems will use liquid propellants. However, the development of high performance, stable liquid engines still requires a large degree of costly trial and error testing. Reducing these development costs will be crucial to meeting Air Force missions within existing budget constraints and to maintaining U.S. competiveness in space.

One important way development costs will be reduced is through the improved modeling made possible by Computational Fluid Dynamics. Many codes applicable to liquid rocket engines have been developed, but a common weakness is that the physical mechanisms contained within them remain unverified under realistic rocket conditions. This topic solicits innovative measurement techniques that will help verify physical mechanisms specifically in the area of spray combustion. Commercially available instruments are currently able to measure drop size and velocity distibutions in a spray, but work best under low pressure, cold flow, dilute spray environments. To be more useful for liquid rocket engine development, these measurements need to be extended to include high pressure cold flow regimes, and/or high pressure hot flow regimes, and/or dense spray regimes. Of particular interest would be in situ measurement of gas/liquid mixture ratios and measurement of condensed phase properties such as drop temperature and composition. Inovative concepts are sought to expand the frontiers of spray measurement technology in these areas.

Phase I: Should identify and demonstrate the feasibility of novel spray measurement technology.

Phase II: Should develop the concept(s) identified in Phase I into a workable prototype instrument.

Dual Use Commercialization Potential: The instrument developed under this program would have widespread commercial applications not limited to rocket propulsion. Examples include automotive gasoline and diesel engines, gas turbine combustors for land, sea, and air applications, fossile fueled furnaces of all types, hazardous waste incineration units, and other noncombustion applications involving particulate flows.

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AF94-086TITLE:High Flux Gas Phase Atomic Boron or Carbon Source

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop a gas phase, high flux source of atomic boron or carbon, compatible with cryogenic storage of solid hydrogen.

DESCRIPTION: Cryogenic solid propellants may provide revolutionary advances in rocket propulsion. Solid hydrogen with mixtures of energetic atoms are relatively difficult to form and store for long periods of time. If these cryogenic hydrogen fuels containing useful concentrations of atomic additives are to be useful for rocket propulsion, a high flux source of gas phase boron atoms or carbon atoms needs to be developed that will have the following characteristics: a. Must produce greater than 90% pure atoms and must not contain greater than 1% non-boron or non-carbon containing species. b. Must be compatible with mixing into gaseous hydrogen without reaction (for deposition onto cryogenic surfaces) and ultimately for bulk deposition at less than 5K (-268 degrees C). c. Must produce atomic flux levels adequate to produce at least one gram of solid cryogenic hydrogen containing at least 2 mole percent isolated boron or carbon atoms within one hour.

Phase I: Phase I must include construction and testing of a prototype source and experimental verification of the desired boron atom or carbon atom flux levels. The results of the Phase I effort must include a detailed practical design which will be built in Phase II.

Phase II: The results of the Phase I effort must conform to the above description and include a detailed practical design which will be built and delivered to the Phillips Laboratory, Propulsion Directorate, in a Phase II effort.

Dual Use Commercialization Potential: Phase III efforts will be directed toward integration of this source into production of cryogenic mixtures of boron atoms or carbon atoms in solid hydrogen for use as advanced rocket propellants. Such advanced propellants may increase the comercial capabilities of launch systems. The atom sources may also be used for implantation of boron or carbon into semi-conductors or advanced materials.

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AF94-087TITLE: Ammonium Nitrate Phase Stabilization and Processing for Environmentally Clean and Safe Propellants

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop a phased-stabilized ammonium nitrate for use in a high energy glycidyl azide polymer (GAP) type, minimum smoke and environmentally clean propellant.

DESCRIPTION: The use of ammonium nitrate as an oxidizer for solid rocket propellants in the past has been unsuccessful due to the temperature and hygroscopic-dependent phase transitions of the ammonium nitrate crystal.

Attempts to stabilize these transitions, especially at storage temperatures, with metal oxides has led only to a decrease in ballistic performance, poor mechanical properties and environmentally undesirable combustion byproducts. A non-metal phase-stabilized ammonium nitrate incorporated in a GAP binder system would virtually eliminate these undesirable effects.

Phase I: Select, process and test several candidate stabilizers for methods of inclusion in/on the AN crystal utilizing thermal analysis, IR spectroscopy, hazard/compatibility and ISP data. In addition to stabilization through crystal inclusion, crystal growth and hygroscopic control will be studies using AN coatings, dessicants and process environment control.

Phase II: Conduct small-scale propellant formulations and accelerated aging studies to ascertain the efficiency of the stabilizer to prevent propellant grain growth. Optimize propellant properties and obtain mechanical, aging, hazards and small-scale ballistic properties. Large-scale (15 lb and 70 lb) ballistic tests will also be conducted.

Dual Use Commercialization Potential: Transition to Phase III will implement environmentally cleaner ammonium nitrate oxidizers as a replacement for presently used ammonium perchlorate in solid propellants.

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AF94-088TITLE:Reducing Bondline Failure Modes in Solid Rocket Motors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop new techniques and/or sample types required to improve the reliability and reproducibility of solid rocket motor bondlines.

DESCRIPTION: One of the major causes of solid rocket motor failures has been that of bondline failure. In particluar, the case/insulation or insulation/liner/ propellant bondlines have been a source of failure in approximately 53% of solid rocket motor firing failures. There have been several Air Force programs on this subject over many years and there is currently a NASA program addressing various components of this problem. In spite of the previous work, aspects of this problem are still unsolved.

This problem can be addressed by employing new techniques and/or types of samples, to perform bench level testing on case-epoxy-insulation and insulation/liner/inert propellant samples to evaluate techniques and samples for possible utility in solving this problem. All techniques should be applicable to aged specimens. A start at modeling these results should be made. Congnizance of the relationship between sample testing and usefulness of using the

results to discuss reliability of rocket motors should be implicit in work performed. This part of the problem has never been adequately treated by the solid rocket motor industry.

Additional work should be performed by scaling up the techniques/sample choices by producing inert solid rocket motors, ending with at least a 70 lb Bates size and demonstrating the applicability of the earlier work. An aging program must be implicit in this part of the program. This phase should include dissection of the motor to test samples and verify the techniques.

Phase I: Should identify the techniques and/or of samples to be used in solving this problem.

Phase II: Should demonstrate applicability to scale-up by producing an inert motor and dissecting it.

Dual Use Commercialization Potential: These results could be commercialized to the composites industry and any commercial venture dealing with adhesion problems.

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AF94-089TITLE:Health Monitoring Devices for Solid Rocket Motors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop and demonstrate embedded sensor technology applicable to monitor state of health of solid rocket motors.

DESCRIPTION: Solid Rocket motors are relatively simple structural systems consisting of motor case, solid propellant, and the bondline region in between. A considerable amount of effort has been spent on developing intelligent structures by coupling embedded senor technology with the structural system. Embedded sensors can be used to monitor both the physical and chemical changes (like soften, hardening, and loss of strength) as well as chemical changes (like water absorption, ingredient migration, and percent of available plasticizer) that occur in solid rocket motors as they age. As the required useful lifetime of the solid rocket motor fleet increases, assuredness of individual motor health and operability is essential. This research effort is intended to develop and demonstrate those innovative technology areas necessary to transition embedded health monitoring sensors from the lab bench to operational rocket motors. Areas of concern are correlation of sensor data aging affects, affects of embedded sensors on rocket motor performance and aging, design of motors and cases for embedded sensors, and demonstration of health monitoring capabilities.

Phase I: Phase I efforts will assess and demonstrate through bench level testing, concept evaluation, and analysis of supporting technologies, concepts for health monitoring of solid rocket motors.

Phase II: Phase II will demonstrate embedded sensor, health monitoring technologies through bench level and scaled motor testing. Deliverable items will be demonstration article testing results, performance analyses, and

instrumented motors for testing and aging surveillance studies.

Dual Use Commercialization Potential: Phase I and II results will be commercialized through the solid rocket motor industry. Other commercial markets can be addressed through investigating bio-compatability for appropriate sensor techniques, remote sensing in high hazard environments, and applicability to composite part manufacture.

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AF94-090TITLE:Electric Propulsion Thruster for On-Orbit Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop and validate methods of improving the performance of electric propulsion thrusters for on-orbit applications.

DESCRIPTION: Electric propulsion thrusters can achieve on-orbit maneuvering and station keeping capabilities that more than double those of chemically based systems. With an electric system, substantially greater amounts of energy can be deposited in the flow. The performance of these devices increases as more energy is added to the flow, but is finally limited by thruster material properties and system energy loss mechanisms. The goal of this SBIR is to develop and validate innovative electric propulsion (EP) concepts capable of near term application; projects involving both enhancements to existing thruster configurations and new thruster concepts can be considered. Due to the rapid advance of materials technology and numerical and experimental analysis tools, the potential for significantly increasing both the physical capabilities of the thrusters and their underlying operating efficiencies is great.

Phase I: Develop electric propulsion thruster concept with performance capabilities significantly exceeding those of existing EP devices: primary interests are high efficiency, high specific impulse, long lifetime, minimal spacecraft contamination and packageability. The thruster should be optimized for on-orbit maneuvering and station keeping missions. The thruster should maintain high performance operation over a throttlable mean power reange form 2 to 10 KW electric. The emphasis in Phase I is on the validation of the innovative concepts that will provide the stated performance improvements. Experimental and theoretical methods can be considered; government and commercial test and evaluation facilities may be utilized.

Phase II: Apply the results of Phase I to the design, fabrication, experimental validation, and optimization of EP thruster performance capabilities. The design process is expected to be iterative with the thruster with the best overall performance being reproduced and be deliverable at the end of the Phase II period. The technology developed has direct impact on the critical military need of Propulsion and Vehicular Systems Technology. Other military and commercial applications include orbit raising of payloads using scalable systems.

Dual Use Commercialization Potential: Dual use commercialization would occur through the development of flight quality electric propulsion systems for satellite and space experiment applications. Improved electric propulsion thrusters will extend mission lifetime, increase spacecraft maneuverability and reduce system mass. Both mission

capability and profitability will increase through the introduction of these thrusters into the marketplace. The outlook for commercialization therfore appears quite favorable.

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AF94-091TITLE:Environmental Approaches to Solid Propellant Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop enviromentally advanced approaches to solid propulsion technology that will assure full compliance with present and impending environmental legislation.

DESCRIPTION: Increases in environmental restrictions affect production, test, mission, and disposal of Air Force systems using rocket propulsion. To remain in compliance with existing and impending regulations new approaches, materials, and processes will have to be developed. This will include the development of: 1) innovative concepts for solid propulsion which transcend current scavenged, neutralized, clean, and solution propellant approaches; and/or 2) new components or ingredients for environmentally acceptable solid rocket propellant; and/or 3) novel, environmentally enhanced approaches to propellant processing, testing, and disposal and disposal that will lead to program goals such as: waste elimination, waste recycling, solvent reduction/replacements, and toxic exhaust reduction.

Phase I: Will identify and evaluate innovative concepts, outlined in the Description above, that could lead to approaches that are economical, feasible, able to meet current performance (ISP, Burn Rate, Mechanical Properties, ect..) for an existing propulsion system, and be in full compliance with all existing and proposed or impending environmental regulation governing the areas where operations occur.

Phase II: Efforts will produce a technical baseline form which a demonstration of capability as a form, fit, and function for a specific system (as predicted in Phase I) can be demonstrated. Demonstrations in the form of test motors up to 800 lbs. will be performed.

Dual Use Commercialization Potential: Under the Federal Facilities Act 1992 all Federal installations must comply with the same environmental regulations as private, industrial concerns. Consequently, the environmental technology developed in producing, processing, testing, and disposing of propellant will be transferrable to related commercial sectors. Commercial space ventures are in need of environmentally advanced propulsion systems to meet future regulations and restrictions. Similarly, related energetic materials industries (i.e. pyrotechnics and explosives) could benefit from the technology developed in this program. capability as a form, fit, and function for a specified system as predicted in Phase I of the program. The development of environmentally acceptable propulsion systems will

be valuable to, not only the services, but to commercial space ventures as well.

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AF94-092TITLE:Advanced Rocket Propulsion Technology

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: The objective of this effort is to develop innovative rocket component technologies, component manufacturing techniques and component integration technologies which will contribute to the doubling of existing rocket propulsion capabilities by the year 2010.

DESCRIPTION: The Phillips Laboratory (PL) is in need of new, innovative approaches in the development of technologies which can double the existing rocket propulsion capability by the year 2010. Specifically, technologies that can increase the reusability of cryogenic liquid rocket engines from 3 to 100 flights prior to overhaul, decrease the cost and time of manufacturing solid rocket motors by 50%, increase the payload capability of existing launch and upper stage propulsion systems by 7%, reduce the number of parts for a cryogenic turbopump by 80%, integrate high energy density material into future rocket propulsion systems and reduce the environmental hazards of the rocket motors by 80%. Latitude is provided to the innovative scientist and engineer to address propulsion related technologies not specifically addressed by other rocket propulsion topics. For instance, electric propulsion concepts and solar thermal rockets show great promise for space applications. Solar rocket powered orbit transfer vehicles development might include research on solar rocket large space structures, Gossamer structures, payload integration, means for otbital Sun-tracking, optical quality mirrors and measurement devices, energy storage/conversion, solar boiloff propellant tankage, micro-thrust stands, thin film concentrator systems. Other advanced rocket concepts previously mentioned would have an equally lenghty shredout of potential research subjects but are not stated in the detail of the solar example. Research in these advanced rocket propulsion topics are included and structured to provide a maximum of innovative flexibility to prospective investigators.

Phase I: The initial research in this effort will assess existing capabilities and demonstrate through bench scale evaluation of the proposed new approach, the payoff to be derived by implementing the concept.

Phase II: Phase II will demonstrate selected advanced rocket technology concepts beyond bench scale and conduct verification testing of the concept.

Dual Use Commercialization Potential: Advanced rocket propulsion technology will transition to the US commercial space launch industry, thus enabling the US industry to better compete with foreign sources for space launch opportunities by reducing the cost of inserting payloads to space orbit. Advanced rocket propulsion technology also serves the commercial sector by enhancing our ability in remanufacture and maintenance of the US ballistic missile fleet.

AF94-093TITLE:Improved In-Situ Tropospheric Humidity Sensor for Accurate DMSP Calibration

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a sensor for providing improved mid and upper troposphere humidity measurement on a routine basis

DESCRIPTION: The present standard technique for measuring the amount of water vapor present in the atmosphere as a function of height is the balloon-borne hygristor. Presently used hygristors provide humidity data with large inaccuracies, especially in conditions of low relative humidity. More detailed and accurate measurement of the distribution of water vapor throughout the troposphere is needed for research purposes, such as global change and environment monitoring, and for operational purposes, such as improved weather forecasting and cloud dynamics models, impact assessment on propagation in the microwave and infrared, and on satellite retrieval methodologies. Truly global measurement of water vapor can only be accomplished using satellite platforms. However, the emerging satellite systems require improved in-situ humidity measurements to develop the retrieval techniques which overcome limitations such as biases, poor vertical resolution, inability to measure in the presence of clouds, and problems with varying microwave surface emisivities. The balloon-borne radiosonde is the principle source of upper air humidity data and should be considered the primary operational platform for obtaining measurements with an improved sensor. Consequently, the additional cost of the improved humdity device should not be large relative to the cost of a synoptic radiosonde measurement, which is about $200 per release. The multiplicity of needs for an improved humidity sensor requires that it perform reliably and accurately over the fully range of global tropospheric variability.

Phase I: Phase I should provide a presentation of sensor alternatives, criteria for selecting an optimal alternative, 15 units of a laboratory model of the selected sensor, initial laboratory testing suitable to predict sensor performance characteristics, a test plan to demonstrate its performance and an estimate of the costs for routine production of the sensor.

Phase II: Phase II will produce at least 100 units of engineering test models, performance of the test plan from Phase I, a test report presenting and analyzing the results of the laboratory and field (radiosonde) tests, recommendations for refinements to optimize production units and a detailed cost estimate for production units.

Dual Use Commercialization Potential: An improved sensor developed under this effort has a ready market. The National Weather Service procures over 50,000 radiosondes a year, each containing a humidity sensor. There is also an international market for approximately 150,000 radiosondes per year. Several US radiosonde manufacturers are active in both of these markets.

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AF94-094TITLE:Geophysical Techniques for Characterizing Hazardous Waste Sites and Remediation Monitoring

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Development of new or enhanced geophysical techniques for characterizing hazardous waste sites and remediation monitoring.

DESCRIPTION: Geophysical techniques can provide fast, cost efficient and non-intrusive means to both characterize and monitor the remediation of hazardous waste sites. A diverse variety of techniques such as seismic, electrical and electromagnetic, ground penetrating radar and magnetometry have been developed by the hydrocarbon and mineral exploration industries. These techniques can provide a complete characterization of the subsurface in terms of its physical properties. The interpretation physics for all of these techniques is applicable only under very limited conditions, e.g., exploration of the deep (greater than 1000 meters) subsurface geology in either seidmentary (oil and gas bearing rocks) or mineral bearing rocks. These same techniques have unlimited potential to provide information regarding the shallow (less than 300 meters) subsurface environment. But, a major impediment in the application of the techniques is our lack of knowledge of the physical response, both seismically and electrically, of shallow unconsolidated soil and fractured rock environments. These are exactly the regimes in which we face the greatest problems in terms of hazardous waste site characterization and remediation. The development of new and novel geophysical techniques are desired that are applicable to hazardous waste site characterization and remediation monitoring to address two outstanding environmental problems: (1) identifying the subsurface location of dense non-aqueous phase liquids (DNAPLs); and (2) effective characterization of fractured bedrock permeability. DNAPLs are heaver than water pollutants such as trichloroethylene (TCE)> When released, they sink to the bottom of aquifers and can pool into a variety of geological traps, e.g., clay lenses, bedrock depressions or bedrock fracture systems, thereby continuing to act as long-term secondary sources and making remediation difficult, if not impossible. The determination of bedrock permeability is a long-standing and important problem whose solution is key to understanding the subsurface environment for the successful design of many remediation programs. Intact crystalline bedrock, commonly found in the northeastern US, has very low permeability. However, if the bedrock is fractured, its permeability can increase several orders of magnitude. Presently, there are no proven techniques, adequate for routine field application, to identify and locate subsurface bedrock fractures or provide an estimate of the effective bedrock fracture permeability.

Phase I: Proposals must demonstrate strong potential for adaptation to field applications. It is recognized that no one technique may be sufficient and the best approach may be one that integrates a number of techniques and methods.

Phase II: Phase II should implement and field demonstrate the concepts developed in Phase I.

Dual Use Commercialization Potential: There is significant potential for the research in this area to lead to commercialized products. There exists a large gap in available techniques and instrumentation for application in the field. Examples include: existing ground penetrating radar (GPR) instruments are cumbersome and generally utilize a short frequency pulse to probe the ground and have little signal analysis or processing capability. This research offers significant advances in producing GPR data analysis techniques, associated data processing algorithms, and subsequent "field ruggedized" instrumentation. Interpretation techniques which integrate electrical and seismic methods have yet to be exploited. This research could lead to a combined field system which samples both electrical and siesmic properties simultaneously in the field. Existing signal processing techniques require too much computer power to be applicable to the field. New techniques are necessary to allow the investigator to have a "quick look" at the data in the field before returning to the lab.

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AF94-095TITLE:Lattice-Gas Parallel Supercomputer for Fine-Grained Modeling of Complex Geophysical Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop a billion-site cellular automata machine optimized for lattice-gas simulation of of geophysical processes.

DESCRIPTION: Recently we realized the confluence of two important events: the discovery of a spatially discreet tranpsort theory and the construction of a programmable matter machine. There now exists a first-principles lattice gas automata (LGA) formalism for modeling complex systems. Also, there now exists cheap, fast parallel hardware which LGA can exploit and usual finite-difference methods cannot. Therefore, we propose building a low-cost next-generation cellular automata machine (CAM). The CAM will be used by the Geophysics Directorate of Phillips Laboratory to research atmospheric dynamics. The CAM will support three-dimensional time-evolved atmospheric simulation of convection, conduction, latent heating, and other physical effects involved in the solar and terrestrial radiation-transfer driving a complex background's thermal signature.

Seek bold and innovative research to construct a massively parallel CAM optimized for lattice gas calculations. The CAM should have approximately one-billion processing sites with at least 16-bits of state data per site. The CAM must occupy a volume small enough for easy placement atop or beside a desk and require only air cooling. The CAM may be controlled by a UNIX engineering workstation front- end. Data visualization and frame-buffer hardware should be integrated into the CAM design allowing for video-rate data acquisition. The CAM may also exploit high density hybrid circuit board design technology to reduce weight and power consumption. This CAM will be a prototype for an eventual field-worthy tactical supercomputer used for real-time intensive geophysical calculations.

Phase I: Provide complete design specifications for the tactical CAM architecture including digital schematic capture, board routing, mechanical housing, cooling analysis, and visualization integrated design. Design specifications should also include details determining operating system architecture for handling initialization data, lookup-table formats, display palette tables, etc. The design must include robust error detection in hardware and software.

Phase II: Upon acceptance of the Phase I designs, commence the fabrication of a billion-site CAM. Two prototypes will be constructed and tested with lattice gas automata algorithms provided by the government.

Dual Use Commercialization Potential: Novel parallel computational algorithms and architectures are perhaps the most important and necessary future advance in US high-performance computing technology. It is well recognized by the scientific community that new parallel strategies are needed for solving current grand challenge problems confronting our industrial and governmental laboratories today. Lattice-gas methods, started principally in the mid-1980s and currently undergoing vigorous research, are a promising parallel computing strategy because of their exactly computable nature over a fine-grained simulation space. A large cellular automata machine architecture,

optimized for lattice-gases, should be ideal for solving many problems important to the commercial sector. Some of the latest applications being explored at universities include: medical imaging in relation to staining and 3D visualization of tomographic scans, biophysics in the studies of polymer dynamics, and electrical engineering in the studies of gate array logic simulation. Perhaps the most important commercial application to date uses lattice-gas methods to model the flow of immiscible fluids through porous media which is currently suported by and benefitting the oil industry. In short, a large billion-site CAM with its spatially discrete lattice-gas software formalism open the door to new computational opportunities to explore the dynamics of complex collective systems ranging across the spectrum from fluid and biophysical systems to even economic systems.

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AF94-096TITLE:Realistic Weather Visualization in Computer Simulations of Military Systems and Operations

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop new and innovative approaches to provide realistic, quantitatively accurate weather depictions in computer simulations of military systems and operations.

DESCRIPTION: Natural and man-made environments form the "playing field" on which lifelike computer simulations of military systems and operations take place. This playing field must be accurately modeled in order that the impact of the environment on equipment and operations be similar to what were to happen in the real world. The environmental research community has developed numerous data bases and physics-based computer models to characterize the environment, and to predict its evolution over the course of a simulation. However, they have concentrated on display of the results of their computer models for research purposes, emphasizing visualization of the underlying physics phenomena rather than subjective or perceptual realism. In contrast, the simulation community has been pressed to provide realism in the displays, e.g., making clouds look like clouds even at the expense of the underlying physical equations. The goal of this effort is to develop the technology that provides both realistic-looking and quantitatively accurate displays of environmental conditions in simulations.

Phase I: Phase I would develop the proof-of-concept of the approach.

Phase II: Phase II would be the design of the system.

Dual Use Commercialization Potential: Commercial potential will be significant as the private sector embraces the simulation for design and operation of commercial systems that operate in the atmospheric environment, for training operators of these systems, and by the TV industry for animated weather displays.

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AF94-097TITLE:Totally Solar-Blind Ultraviolet Detectors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop and fabricate ultraviolet detectors with insignificant sensitivity to visible/infrared solar radiation.

DESCRIPTION: Innovative ultraviolet detectors are sought to replace the well-known, but inaccurately named "solar-blind" sensors which cannot be used in space applications without cumbersome additional filters. Devices proposed must be intrinsically sensitive to the ultraviolet (about 400 to 10 nanometers), or a portion thereof, and have insignficant sensitivity (or "red-leak") to visible infrared solar flux. Improvement to cesium telluride and similar photocathodes currently used is sought. Additional desirable innovations would be the ability to tailor the onset of ultraviolet sensitivity and improved quantum efficiencies. High work-function materials or other innovative techniques should be suitable for immediate use in space applications, possibly both as single channel and as array detectors, at the conclusion of this effort.

Phase I: Demonstration of materials and techniques that are promising for incorporation into devices will be accomplished in this phase.

Phase II: Fabrication of devices such as image tubes, photomultipliers, and/or photodiodes, or equivalent, suitable for application to ultraviolet atmospheric remote sensing measurements will be the goal of this phase.

Dual Use Commercialization Potential: Opportunities are in the use of both single channel and array imager detectors. One such use is for environmental health monitors of the "UV-B" radiation now increasing globally at the Earth's surface because of loss of stratospheric ozone. Use is made of UV detectors to sense the presence or absence of flames in building heating system boilers, aircraft, and industrial processing. A developing use is in the manufacture of microelectronics components where microlithography in the so-called "Deep UV" region is being widely applied. Finally, the use of UV lamps to cure printing inks in high speed presses depends on UV sensors to keep the process controlled. The sensors being developed here would be simpler and, therefore, more suitable for printing plant use. Results of this effort will provide cheaper and simpler sensors compared to the current practice.

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AF94-098TITLE:Synoptic Climatologies for AI Weather Support to the Battlefield

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Define meteorological entities and processes in computer code suitable for use in future expert weather forecast systems.

DESCRIPTION: Currently, every meteorological expert system developed must include definitions of meteorological entities, together with the appropriate ranges of any measurable quality associated with them. For example, an air-mass is a meteorological object with characteristic moisture, temperature and stability attributes. A warm tropical maritime air-mass has an entirely different range of appropriate values for these quantities than does a cold polar continental air-mass. Each new meteorological expert system that refers to air-masses must redefine them. This laborious task detracts from the effort devoted to generating the knowledge base that is the heart of any expert system. In particular, the lack of a library of common meteorological entities and processes in an appropriate database prevents the development of computerized synoptic climatologies. Synoptic climatology differs from statistical climatology in providing the characteristic weather pattern for a region (including most prevalent air-mass type), rather than simply monthly averages of weather parameters such as temperature and precipitation. In the past, the lack of computerized, accessible synoptic climatologies has hampered Air Force weather forecasters operating in unfamiliar regions under data-sparse conditions.

Phase I: Phase I of this project will consist of collating and defining the majority of commonly encountered meteorological objects and processes and listing their attributes. The minimum objectbase resulting from this effort will contain all the objects necessary to incorporate the synoptic climatology provided to the successful bidder by the government.

Phase II: Phase II will consist of coding of this library into a meteorological database and selecting appropriate values for the attributes, based on physical principles and general climatology. As a test of the completeness and accuracy of the objectbase, all available synoptic climatologies will be incorporated into the system.

Dual Use Commercialization Potential: The resulting meteorological library and synoptic climatologies will form the basis of a domain-specific (meteorology) expert system shell. This will be a viable commercial product with a world-wide market for anyone interested in tailored weather forecasts.

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AF94-099TITLE:Rocket/Missile Technologies

CATEGORY: Exploratory Development

OBJECTIVE: Develop and/or adapt innovative or commercial derivative technologies to advance environmental acceptability, safety and cost to the user of rocket or missile systems

DESCRIPTION: This category of innovative research and development is intended to solicit technologies, and unique technology applications, that could be applicable for future rocket/booster/missile systems. Three areas of particular interest are environmental acceptability, system safety and cost-to-the-user. Specific interest in these areas does not preclude an offerer form suggesting other innovative technology application. Specific subtopics could include, but not be limited to: environmentally acceptable propellants (production through use), environmentally acceptable processes and resins for the production of nozzles, propellant cases, and thermal protection heatshields; advance positive control

and system performance interactive monitoring through adaptations of virtual reality environments, artificial intelligence; advanced system monitoring, fault detection and isolation, and performance implications simulation analysis using derivatives of NDT&E to minimize performance risk and extend the life-cycle of components, subsystems and systems, advanced in-situ monitoring technology; low cost nozzles and thrust vector control subsystems, and modular integration stage designs for large payload flexibility. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

Phase I: Provide preliminary technology designs for innovative technologies proposed in this topic. Designs should serve as a point of departure for government evaluation of the mission and system utility of each candidate Phase I award.

Phase II: Prototype development of technologies sufficient to demonstrate and validate the technology applicability to the long range ballistic missile technology needs.

Dual Use Commercialization Potential: Environmentally acceptable propulsion/launch capability, lower cost critical components to reduce cost per pound.

Reference were not provided since this topic covers such a broad range of technology and is intended as a solicitation for new and creative ideas.

AF94-100TITLE:Replacement Refrigerant for R-502 Refrigerant Based Environmental Control Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop environmentally acceptable "drop-in" R-502 replacement refrigerant or design a replacement OLDS free refrigerant system.

DESCRIPTION: A need exists to identify innovative coolant systems that are not OLDS refrigerant based and are capable of providing reliable, low maintenance, cooling over long periods of time. The use of R-502 refrigerant ranges from use in the environmental conditioning systems in strategic missile silos to air conditioning of large buildings. Although this material is a blend of chlorofluorocarbon materials, and has an Ozone Depletion Potential of 0.307, it will be banned in the near future, along with other CFC type materials. A critical need exists for an innovative, non-flammable thermodynamically equivalent, environmentally acceptable lubricant compatible, replacement for R-502. Accordingly, the need is for a "drop-in" R-502 replacement which requires no (or minimum) modification to existing environmental conditioning systems. An alternative solution is to develop a low maintenance replacement system, complete with an environmentally acceptable, cost-effective, non-flammable refrigerant. In either situation, the trouble free life of the resulting system should be in the order of magnitude of 20 years and the physical size of a replacement system (if that turns out to be the solution) should be as small and cost effective as possible.

Phase I: SBIR activity will concern selection of candidate environmentally acceptable, drop-in replacement refrigerants, or design of a replacement equipment/refrigerant system. System designs and operating characteristics will be compared to the current military and commercial R-502 systems. A Phase I demonstration will be conducted to indicate the potential for success in Phase II.

Phase II: SBIR activity will finalize the selected solution, together with construction/modification, test, and qualification of a prototype of the required system.

Dual Use Commercialization Potential: The small business that develops a long-term solution to replace the use of R-502, one of the most widely used commercial refrigerants, will have either developed a highly saleable refrigerant replacement product or a critically needed, commercially acceptable OLDS free refrigerant equipment system.

REFERENCES:

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92. (Available from NTIS as DE92017162/XAB).

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AF94-101TITLE:Solid Rocket Motor Aging, Reliability, Service Life Estimation, and Performance Evaluation Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop surveillance sensors and methods which will support estimation of remaining service life, defect aging, and probability of mission failure.

DESCRIPTION: The application of advanced inspection technologies can be applied to allow determination of defects within a solid motor stage propellant grain. What is needed is the development of advanced sensor technologies and methods which can be applied to determine how critical defects identified within solid propellants effect overall motor performance. This topic solicits development of advanced sensor technologies (both external to the motor as well as internal) which can non-destructively identify changes in the chemical composition, physical configuration and eventual motor performance compared to original specifications for candidate solid propellant motors.

Phase I: Provide preliminary technology designs for various service life estimation technologies which enhance the currently procured aging technologies found in the field.

Phase II: Complete prototype technology development for potential demonstration and validation for available solid propellant motors. Demonstration and validation success will serve as the criteria for consideration into a S&T system development effort.

Dual Use Commercialization Potential: Output from this topic could be used to commercially determine aging, manufacturing quality control, aircraft parts non-destructive evaluation during repair and refurbishment.

REFERENCES:

Lloyd, D.K. "Long Range Service Life Analysis/LRSLA/System Trend Analysis Life Estimating Procedure." Institute of Aeronautics and Astronautics, Society of Automotive Engineers, 12th Propulsion Conference, Palo Alto, CA, Jul 26-29, 76, AIAA Paper 76-746.

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Ekstrom, J.L., et al "Applying Design to Reliability Techniques to a Composite Solid Rocket Motor Case." 32nd Structures, Structural Dynamics, and Materials Conference, Baltimore, MD, Apr 8-10, 91. AIAA Paper 91-1033.

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AF94-102TITLE:Enhanced Precision Cleaning of Critical Parts and Components

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Enhanced precision cleanning of critical parts/components using innovative cleaning processes that exclude Ozone Layer Depleting Substances (OLDS).

DESCRIPTION: The following enhancements are needed for precision cleaning processes used as alternatives for OLDS: (1) provide flourocarbon additives that will remove hydrocarbons, plus facilitate the cleaning of systems that use highly oxidizing substances; (2) provide thorough water removal and improved particle removal in aqueous/semiaqueous processes. Separate or combined proposals are acceptable for the following subtopics.

a. Flourocarbon additives have been developed for highly effective particulate removal. The innovative development of a flourocarbon additive that has the capability to remove hydrocarbon oils, greases, and resin fluxes would result in the creation of a cleaning fluid highly comparable to Freon 113. Such a material will fill a critical need in closed loop, recirculating, precision cleaning processes. In addition, such a solvent may provide an innovative, highly inert, non volatile residue, environmentally acceptable replacement fluid/process to remove highly flamable substance residuals, particulate contaminates, water and other contaminating materials from systems that handle highly oxidizing materials.

b. In aqueous cleaning, the parts are first immersed in an aqueous/ surfactant solution. In semiaqueous cleaning, parts are first immersed in a hydrocarbon based solution. In either case, the contaminate laden solution is flushed from the parts by rinsing the water. A need exists to provide an improved method for removing the rinse water from the cleaned parts. In the past CFC-113/surfactant mixtures have successfully been used as decanting liquids to remove water from the cleaned parts. An alternative might consist of displacing the water by innovative, volatile, nonflammable, immiscible liquid. In addition, both aqueous and semiaqueous cleaning solutions are not effective particulate contaminate removers in the area of < 5 micron particle size. In the case of critical cleaning processes, there is a need to improve the capability of these solutions for removal of small particulate contaminates.

Phase I: Phase I will result in the demonstration of improved flourocarbon, semiaqueous and aqueous cleaning processes applied to selected parts.

Phase II: Phase II will result in the development and implementation of a production precision cleaning process.

Dual Use Commercialization Potential: The contractor who develops OLDS-free enhancements to critical cleaning processes will find wide commercial acceptance for his products. Aqueous, Semiaqueous and fluorocarbon-based processes are OLDS free by nature. Precision cleaning processes utilizaing fluorocarbon materials, contained in currently available closed loop, recirculating cleaning systems are also acceptable from a global warming aspect.

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AF94-103TITLE:Clean Room Approved Packaging Material/Packages

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop Clean Room approved packaging material/packages for temporary storage and transport of cleaned items.

DESCRIPTION: Elimination of CFC cleaning agents has resulted in the creation of localized cleaning centers, which in many instances, are remote from the point of use of the cleaned items. This situation creates the need for innovative, clean room approved, protective, non-contaminating, packaging material and packages in which the cleaned items can be placed for transport to the next location in the production, storage or developmental process. To date, no adequate/convenient packaging method exists that will consistently protect an item from contamination in such a packaging/storage/transport process. A very serious need exists to develop packaging material/packages to protect precision cleaned parts during transit from clean room cleaning centers to assembly areas, test sites, other clean rooms, etc. Required attributes of the packaging material/packages, among others, are: a. Totally impermeable to moisture; b. Completely antistatic; c. cleanroom approved (for up to class 100 clean areas) both inside and out; d. Transparency desirable; e. Conveniently sealable; f. Antishedding/anticontaminating during sealing and opening operations; h. Antishedding/anticontaminating as a result of abrasion of packaged part to packaging material contact and rubbing g. Inert to common solvents, oils and greases.

Phase I: This phase will address innovative material selection/ development, fabrication and sealing processes, validation test procedures, sealing/opening methods, and demonstrate feasibility of approach to the problem.

Phase II: This phase will finalize successful problem solution/ demonstration in actual commercial/DoD production processes.

Dual Use Commercialization Potential: Development of a suitable clean room material and packaging process will have wide commercial and military acceptance throughout all the organizations using clean rooms in their production processes.

REFERENCES:

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AF94-104TITLE:Precision Guidance and Navigation Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Identify, investigate, and develop innovative technologies for guidance and navigation of hypersonic vehicles.

DESCRIPTION: Recent analyses conducted in support of Air Combat Command has considered delivery of hypersonic glide vehicles capable of delivering conventional payloads anywhere in the world. To be feasible, these systems need integrated guidance and navigation subsystems that can provide better accuracy (miss distances of less than 3 meters over ranges in excess of 12,000 KM and lasting almost 2 hours) and significant reduction in the overall cost of ownership than currently available technologies. It is believed that technologies that have multiple applications, especially commercial applications will have a tendency to be more cost effective to procure and to maintain. For this reason, technologies with high commercial potential will be given special consideration. Technologies that are not totally inertial based, but provide for means of position identification or position location error reduction are sought. Due to the hypersonic speeds, constrained weight and available onboard power, size and weight reduction along with low power requirements will be deemed very critical in evaluating prospective technologies. Some of the required guidance and navigation capabilities include: Terminal errors of less than 3 meters; Immunity to active and passive countermeasures; Low procurement costs; Low maintenance costs; and Small size, low weight and low power requirements. Several of the concepts examined might use inertial systems updated by radars, optical sensors, or satellites. Although these concepts would provide good accuracy, they have not been able to meet the combined critical objectives described. Consequently, these concepts serve as a point of departure for innovative techniques and their definition will be made available upon request.

Phase I: Define requirements and design goals for precision guidance and navigation technologies to be further researched and developed in Phase II.

Phase II: Perform analysis, simulations, and complete preliminary designs firmly establishing feasibility. Conduct limited laboratory testing.

Dual Use Commercialization Potential: Small low-cost precision navigation position reference systems could be used commercially for automotive navigation, aircraft control and navigation, commercial transportation, crash avoidance sensors and subsystems, and microminiature manufacturing.

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AF94-105TITLE:Remanufacture of Ammonium Perchlorate Reclaimed from Demilitarization/Propellant Manufacture

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an ammonium perchlorate reclamation process using manufacturer scrap and demobilized missile propellant in the manufacture of new rocket motors.

DESCRIPTION: Recycling of Ammonium Perchlorate (AP) is an environmentally preferable alternative to open burning or open detonation. Recyclable AP is recovered from: (1) the demilitarization of missile motors, and (2) from manufacture of new AP which is unsuitable for use in motors without additional processing (remanufacturing). The

highest value application of the reclaimed AP is in the manufacture of new military and commercial rocket motors. The particle size distribution, crystal shape, density and chemical purity are attributes that are important for ballistic and physical property control in propellant manufacture. Recrystallization of reclaimed AP poses some unique challenges that require innovative solutions. Trace contaminants brought over from other components of the propellant may impact crystal habit (shape of the crystals), nucleation rates and nucleation sites (affecting rate of growth and final crystal size). Also, trace impurities may interfere with propellant curing, burn rate, and mechanical properties. Innovative research is required to develop an efficient, affordable process to remanufacture reclaimed AP in production quantities that satisfies the chemical and physical properties including particle size distribution specified for propellant grade AP. Successful process development will benefit not only environmental concerns but also cost effective manufacture of military and commercial rocket engines.

Phase I: Phase I will define the basic process together with a laboratory-scale demonstration to display its potential for success.

Phase II: Phase II will expand the methodology to a full scale reliable production process, including a production-scale demonstration.

Dual Use Commercialization Potential: This program embodies an environmentally preferred alternative to the disposal of demilitarized rocket fuels coupled with cost effective reuse of surplus/scrap ammonium perchlorate in new military and commercial solid rocket engines and ammonium perchlorate byproducts.

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AF94-106TITLE:Active and Passive Microoptics for Diode Lasers and Amplifiers

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop fabrication and mounting techniques for active and passive microoptics for use with diode lasers and amplifiers.

DESCRIPTION: Semiconductor diode lasers show great promise for both military and commercial applications. One way to achieve the high brightness from some of these applications requires the use of the master oscillator power amplifier approach. In this approach it is necessary to efficiently divide and one-way couple power from the master oscillator to the several amplifiers and then coherently combine the outputs. It has proven difficult to achieve all of the required devices or operations monolithically on one chip. A hybrid approach using microoptics may be more practical. This approach may require anamorphic lenses, beam splitters, phase shifters, polarizers, waveplates, etc., to one-way couple from the master oscillator to the amplifiers and have all the outputs properly phased. This topic is seeking the development of techniques for the design, fabrication, and mounting of such microoptic devices. How the device fits into a whole system should be considered, since it does no good to have a waveguide modulator if there are no microoptics to efficiently and reliably couple into and out of the modulator from the preceding and following devices. Micro mounting techniques as well as microoptics need to be developed.

Phase I: Procedures and processes are developed for the design, fabrication and mounting of individual devices that are compatible with a complete system.

Phase II: A complete system is demonstrated using the procedure, processes and techniques developed in

Phase I. The system must demonstrate a significant capability.

Dual Use Commercialization Potential: The dual use commercialization potential is very high for all of the devices and techniques developed as a result of this SBIR topic, because these are devices and operations used in any optical system and are not unique to military applications.

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AF94-107TITLE:Optical Filters for Ultra-High Rejection of Noise or Laser Wavelengths

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Fabricate and characterize high throughput (0.8), wide-angle (>30 degrees), ultranarrow (<1 GHz), bandpass/band rejection optical filters with high (>10,000,000) out of band/in band rejection.

DESCRIPTION: Large ground-based telescopes require adaptive optics to correct the blurring effects of atmospheric turbulence on imaging and laser propagation. The USAF has demonstrated the use of laser beacons as a light reference source allowing the adaptive optics sensors to measure the wavefront distortions created by the atmosphere. Laser beacons are created by focusing a laser in the atmosphere. A sensor behind the telescope detects light scattered by the atmosphere and adjusts the surface of a deformable or "rubber" mirror to cancel the distortion. It is only possible to use this concept at night since the strength of the signal scattered back into the telescope is very weak. This signal is completely masked by noise from the bright sky in the daytime. Current optical filters have inadequate throughput, out-of-band rejection, and linewidth to permit daytime operation of adaptive optics using laser beacons. In operating laser beacon adaptive optics the sensor must not be blinded by laser light scattered by the telescope optics as the pulsed laser beam leaves the telescope. It is necessary to sense light scattered only from a small "range gate" in the atmosphere where the beam is focused to a small spot. The optical filter must be switchable from high throughput to high rejection, quickly (100 nanoseconds or less) at repetition rates up to 5,000 times per second. It is important to protect other sensors and cameras from the scattered laser light. Also desirable is the ability to configure the filter to operate in a mode that rejects light from a narrow spectral region centered on the laser line wavelength but have high throughput for all other wavelengths. There are requirements for optical filters operating at copper vapor laser wavelengths of 5l0.6 and 578.2 nm and at the sodium D2 line of 589 nm.

Phase I: Select a concept, fabricate a laboratory model, and experimentally characterize its performance. Successfully demonstrate the laboratory model (chosen filter concept) to prove it's feasibility and provide quantitative data which satisfies the following specifications: <1 GHz; transmission: >0.8; out-of-band rejection: >10,000,000; field of view: >30 degrees full angle; switchable from high throughput to high rejection in tens of nanoseconds at rates up to 5,000 times per second.

Phase II: Produce usable filters for test and evaluation in laser beacon adaptive optics experiments at the Starfire Optical Range, Kirtland AFB NM. The filters will be evaluated for throughput, out-of-band rejection, and ability to serve as a range-gating mechanism to reject near field scatter from optics and the lower atmosphere. This phase also includes packing the filter for use in laser beacon adaptive optics experiments on large telescopes with high power lasers. The filters would be needed as high throughput, high rejection, switchable devices for use with copper vapor and sodium frequency lasers and will be operated on 1.5 and 3.5m telescopes with ultrahigh sensitivity, ultra low noise wavefront sensors and cameras.

Dual Use Commercialization Potential: Laser guide star adaptive optics offer a high value commercial application in transmitting electrical power to geosynchronous communications satellites to extend their operational life. The satellite's life is limited by deep cycling of it's batteries during earth eclipses lasting approximately one hour per day for periods of approximately 45 days twice per year. Charging the satellite's batteries with the use of ground based lasers during these periods can extend the satellite's life 5-15 years, resulting in revenues of 20-50 million dollars per satellite per year. Satellite owners are interested in developing a network of ground based sites that could beam power commercially to their satellites on a world wide basis. A large commercial market for narrow band optical filters exists today. Ultra-narrow, high throughput filters developed under this effort would immediately expand this market and find acceptance in many commercial applications, including medical imaging, non-destructive testing, ultra high resolution spectroscopy, surveillance, astronomical imaging cameras, daytime laser communications with GEO and LEO satellites and deep space probes, solar astronomy, and many other applications.

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AF94-108TITLE:Environmentally Clean Beam Path Conditioning

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop a new approach to beam path conditioning hardware for optical systems.

DESCRIPTION: Beam path conditioning (BPC) systems in use at optical stations around the world generally either attempt to flow laminar gas through the beam train or else provide a box-like environment to prevent undesirable currents from entering. While these approaches can work well, we are interested in an improved design for high quality optical trains. The selected approach would provide a near-lossless, high Strehl ratio technique which either measured or controlled the deleterious air turbulence, vibration, and thermal gradient effects. In particular, a concept that can be built in Phase II is desired. One function of the hardware package would be to account for any predictable air flow and minimize air turbulence. A good understanding of air flow and turbulence effects on optical performance is essential. Similarly, seismic vibrations in the beam train can cause acoustical coupling or otherwise disrupt the BPC system. Finally, thermal gradients among optical elements, ambient gas, and container sidewalls can induce optical

degradations. These effects should be analyzed in considerable detail during Phase I so that the eventual hardware program can be used to validate the design in a brassboard environment. The BPC approach itself is to concentrate on "clean" techniques with recyclable constituents, if applicable.

Phase I: The objective of the Phase I program is to produce a BPC design supported by analysis and/or simulation. The successful small business would have to understand optical system characterizations and fluid flow to verify the design in "software".

Phase II: The second phase will require the development of a BPC system for a scaled down brassboard optical train so that individual effects can be monitored and performance evaluated. The Phillips Laboratory (PL) would provide access to such a brassboard for the final level of checkout. Ideally, in Phase III a commercial package should be developed that could be installed in optical systems around the world to mitigate one adverse effect.

Dual Use Commercialization Potential: We expect that the fields of astronomy, imaging, laser propagation, and optical surveillance would be interested in a clean BPC hardware design. A recent example of how clean beam trains can be commercialized is the Laser Guide Star (LGS) adaptive optics technique, which was developed in the defense department and is now being used in the astronomy community. A final dual use commercial technology which can take advantage of the new BPC technique is the "power beaming" of energy to sustain geosynchronous satellites. These expensive satellites occasionally lose contact with the sun and can be resupplied with energy from the ground, but the optical train required to supply that energy would have severe limitations in delivering energy unless the beam train were conditioned to a high level. commercial package that could be installed in optical systems around the world to mitigate one adverse effect. We expect that the fields of astronomy, imaging, laser propagation, and optical surveillance would be interest in such a hardware design.

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AF94-109TITLE:Optically Pumped Mid-Infrared (2-5 micron) Semiconductor Lasers

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop and demonstrate a 10-watt average power, optically pumped, mid-infrared (2-5 micron) semiconductor laser.

DESCRIPTION: Present electrically driven semiconductor lasers require small dimensions (=a few microns) between electrodes in order to confine the current flow to a narrow, well defined channel. This requirement stresses materials and bonding technologies, greatly complicates engineering design, and reduces the lasing volume in conventional semiconductor lasers. One option available which may overcome these difficulties is to optically pump a semiconductor laser with another laser source. This option may allow for greater engineering flexibility in the design of mid-infrared semiconductor lasers and higher output power from a single aperture. If developed, this laser source would have many applications in Air Force, DoD, and environmental monitoring areas.

Phase I: Demonstrate a scalable, mid-infrared (2-5 um) laser pumped semiconductor laser operating at

average power levels above 0.1 watt. The pump source in Phase I may be either solid-state or a semiconductor laser. Optically pumped oscillators or oscillator/amplifier configurations should be considered. A preliminary design for a 10-watt semiconductor oscillator shall be delivered in this phase.

Phase II: Extend the Phase I demonstration to the 10-watt average power level in the mid-infrared. Modeling and analysis of the 10-watt device should be used to determine the power scaling limits for optically pumped semiconductor lasers. The pump source in Phase II must be a semiconductor laser.

Dual Use Commercialization Potential: Most organic chemical species have spectroscopic signatures in the 2-5 micron range. The mid-infrared semiconductor laser is an ideal handheld source for remote detection of chemical species. In addition, eye-safe laser applications such as wind shear sensing and laser radar are ideal spin-offs of this technology.

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AF94-110TITLE:Medical Applications Of Semiconductor Lasers

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Investigate medical applications of the fiber-coupled, semiconductor lasers and determine which applications will benefit most from their unique properties.

DESCRIPTION: Recent improvements in materials growth, processing and architecture of semiconductor lasers have made them very attractive for use in medical procedures. Until recently, the semiconductor laser was not able to produce output powers high enough for medical applications and had a very limited wavelength range. Semiconductor lasers are currently emitting watts of output power from a single device and tens of watts from a single bar. Material systems other than the conventional AlGaAs system have been developed allowing the semiconductor laser to lase from 630 nm to 2.2 um at output powers of 100s of mW or more. With these advances, the semiconductor laser has the potential of replacing most existing medical lasers for continuous wave applications. Building a single semiconductor laser system for a variety of medical applications is very difficult, since each application requires different operating parameters. The high power systems being developed need to be refined for specific applications. It is also important that use of semiconductor lasers in an application be advantageous over other conventional procedures.

Phase I: Select a promising application utilizing semiconductor lasers. The contractor shall perform preliminary investigations to determine laser specifications for the chosen application and required system design parameters. At the end of Phase I, a preliminary design will be delivered.

Phase II: Build and optimize the laser system by conducting tests in the environment in which it will be used. A prototype will be delivered the end of Phase II.

Dual Use Commercialization Potential: These semiconductor lasers will be useful for military applications such as a portable battlefield cut, coagulate, and close device or an illuminator. They will also be useful for any type of hospital or doctor's office, either military or civilian. Applications range from PDT therapy to laser scalpel. The high reliability, compactness, continuous wave operation, variety of wavelengths, and high efficiencies will enable these devices to be versatile, portable units that can be carried from operating room to operating room or between doctor's offices.

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AF94-111TITLE:Nonlinear Optical Generation of Mid-IR Laser Wavelengths

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Demonstrate new optical gain configurations which incorporate nonlinear optics and laser gain in a single cavity.

DESCRIPTION: Most current techniques for generating light in the mid-infrared (2-5 um) require nonlinear optical frequency conversion processes which are inefficient and difficult to implement in fieldable systems. One way to ruggedize the system and possibly increase the efficiency of the process is to develop lasers which incorporate gain and frequency conversion capabilities in one cavity. These sources could be considered monolithic or quasi-monolithic lasers. Additional important considerations involve passive Q-switching and mode-locking methods which could be an integral part of the gain media. These laser sources would have an immediate impact on many Air Force and commercial applications including communications and environmental monitoring.

Phase I: The Phase I effort should be directed toward understanding technical issues associated with laser configurations which incorporate multiple optical processes in a single laser cavity. Experiments, supported by theoretical analysis, should be performed which provide possible candidate nonlinear optical materials and gain media appropriate for generating 2-5 micron laser radiation. Solid-state materials which can be diode laser pumped are required. During this phase, a preliminary design for the Phase II device demonstration should be developed.

Phase II: Phase II should demonstrate a 5 watt, near diffraction limited device which is tunable in the 2-5 micron wavelength region.

Dual Use Commercialization Potential: New 2-5 micron tunable lasers developed under this effort will have a direct impact on commercial solid-state laser applications such as communications, lidar for wind shear and remote sensing, environmental monitoring, materials processing, surgical and therapeutic procedures in the health industry, and other applications which require eyesafe laser wavelengths (greater than ~1.5 microns). Current lasers which are used for some of these applications usually use gas as the gain media or use nonlinear optical frequency conversion elements in conjunction with separate solid-state lasers to generate the mid- infrared wavelengths. Both systems are inefficient

and usually are physically large. Integrated, single cavity lasers for generating mid-infrared wavelengths should be more compact, reliable and efficient, providing the commercial sector an attractive alternative to existing systems.

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AF94-112TITLE:Direct Generation of Near/Mid-Infrared Laser Wavelengths

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Investigate existing and new solid-state gain media which lase in the 2-5 micron band and at 1.178 microns.

DESCRIPTION: Current fieldable techniques for generating light in the mid-infrared require nonlinear optical frequency conversion processes which reduce system efficiencies. One way to possibly increase the efficiency of the process is to find solid-state materials which lase directly in the mid-infrared, particularly in the 3-5 micron band. Also of interest are solid-state materials which lase at 1.178 microns. Frequency doubling at 1.06 microns has been accomplished at efficiencies exceeding 70-80 percent (optical to optical), so frequency doubling 1.178 microns to 589 nanometers could produce similar efficiencies. We are seeking proposals in these areas. On-going research in the Air Force, other Government organizations, in the environmental monitoring community, and the astronomical community can benefit from solid-state laser materials research in these areas.

Phase I: The Phase I effort should be directed toward researching the physics associated with solid-state materials which lase in the 2-5 micron band or at 1.178 microns. Nonlinear frequency conversion processes should not be considered. Experiments, supported by theoretical analysis, should be performed which provide possible gain media candidates. Materials which can be diode-pumped are preferred. During this phase, a preliminary design for the Phase II device should also be developed.

Phase II: Phase II should provide expanded proof of concept by fabricating a greater than 10 Watt average power, less than two times diffraction limited, mid-infrared laser source.

Dual Use Commercialization Potential: New 2-5 micron laser materials developed under this effort will have a direct impact on commercial solid-state laser applications such as lidar for wind shear and remote sensing, environmental monitoring, materials processing, surgical and therapeutic procedures in the health industry, and other applications which require eyesafe laser wavelengths (greater than ~1.5 microns). Current lasers which are used for some of these applications usually use gas as the gain media or use nonlinear optical frequency conversion elements in conjunction with solid-state lasers to generate the mid-infrared wavelengths. Both systems are inefficient and usually are physically large, which limits their viability. Laser materials which lase at 1.178 microns will provide a source for frequency doubling to 589 nanometers, a wavelength used both the DoD and the world-wide astronomical community to perform atmospheric compensation research.

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AF94-113TITLE:New Laser Concepts For Air Force And Private Sector Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop novel lasers for communications, countermeasures, and remote sensing.

DESCRIPTION: The next generation of laser devices for the Air Force must be high power, efficient, and extremely compact sources. Monolithic semiconductor and solid-state sources which incorporate microoptics and high modulation rate optical modulators in a common structure for stability, reliability, and ease of operation are desired. Average output power should be in the 20-50 watt range with near diffraction limited beam quality. Direct lasing devices in the eye safe (1.5-10 micron) and ultraviolet (<0.4 micron) wavelength ranges are of interest. Proposers may submit new concepts for laser devices, microoptics technologies, thermal management, die bonding, materials development, modulation schemes, or other important technologies supporting next generation laser devices for the Air Force and private sector. Novel, broad area, single aperture semiconductor lasers, compact, monolithic solid-state lasers, and unique high power array architectures will have application in future Air Force communications, countermeasures, and remote sensing missions. Commercial applications for this technology include environmental pollution monitoring, wind sensing, read/write data storage, and communications.

Phase I: Develop preliminary designs and perform analysis to select most promising candidate. Laboratory demonstration of the selected concept is preferred but not required.

Phase II: Further develop and demonstrate the chosen Phase I design/concept. The contractor shall deliver any hardware/software developed, document the work performed and develop a plan for technology transition and insertion into future systems and other commercial ventures.

Dual Use Commercialization Potential: The lasers developed under this program will be useful for many civilian applications. The remote sensing applications pollution monitoring of industrial plants and waste sites, process monitoring in manufacturing, identification of agricultural and plant species and growth conditions, and oil surveys. Other spectroscopic techniques include medical applications such as glucose monitoring. Examples of medical applications include photo dynamic therapy for cancer, tissue cutting, and cauterization. Lasers for wind sensing will transfer to commercial aviation for wind shear detection. Short wavelength lasers will apply to high density data storage and retrieval as well as high brightness color video displays.

AF94-114TITLE:USAF-Phillips Laboratory: Technology Transfer/dual Use

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Stimulate the transition to a national industrial capability providing the most advanced, affordable, military systems and the most competitive commercial products.

DESCRIPTION: The Phillips Laboratory (PL) is the premier DoD organization conducting R&D in military space, missiles, directed energy, and geophysics technology. Ongoing or previous R&D efforts at or on behalf of the PL often result in specific state-of-the-art technological innovations which, due to USAF priorities, are not developed as a product. Many of these technologies, if properly developed and refined, may offer truly innovative solutions to a great many DoD and commercial requirements. Additionally, the proposer may have developed technology that may solve both PL and commercial scientific and/or engineering problems if properly refined or developed. The following are the areas of technical interest to Phillips:

PROPULSION - Advanced concepts involving motors and propellants and test techniques.

GEOPHYSICS - Research to further Air Force understanding of the environment between the earth and the sun and its effects on systems and and operations.

SPACE and MISSILES TECHNOLOGY - Work on spacecraft structures, power and thermal management, sensors, electronics, and navigation technology.

LASERS and IMAGING - Demonstrating the technical and engineering feasibility of lasers and imaging systems.

ADVANCED WEAPONS and SURVIVABILITY - Developing high energy plasma and microwave technologies, electromagnetic pulse hardening, space systems survivability, and advanced techniques and computer simulations for weapons effects.

SPACE EXPERIMENTS - Managing and conducting space experiments in a ground, balloon-borne, aircraft or space mode, along with related ground acceptance and space/launch environmental testing.

Proposers should take care to describe the dual use (both military and commercial) and/or transfer potential of the technology. PLEASE NOTE that proposals submitted under this category will be first be evaluated for relevance to dual use objectives. Relevant Phase I proposals will then be evaluated in accordance with criteria specified in section 4.2 of this solicitation. Emphasis will then be placed on the potential of the proposer to bring a product to market through commercial track record, alliances with others who have successfully commercialized a product, or a strong commercialization strategy.

Phase I: An in-depth assessment of potential commercial and military applications will be require. As a result of this assessment, the initial necessary concept refinements will be determined and designed.

Phase II: Build or fabricate, test and validate a laboratory demonstration model or prototype based on the commercial/military applications assessment and the design refinements.

Dual Use Commercialization Potential: The range of technologies addressed by this topic and of interest to the Phillips Laboratory are expected to positively impact private sector interests in communications, advanced electronics, medicine, transportation, manufacturing, and environmental sciences, as well as a great many other markets.

AF94-115TITLE:Lightweight Nitrogen Dioxide Vapor Detector

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an inexpensive, lightweight, Nitrogen Dioxide vapor detector for monitoring personnel exposures to oxidizer vapor.

DESCRIPTION: Nitrogen tetroxide is widely used as a rocket propulsion oxidizer in space launch operations. Nitrogen dioxide (NO2) gas exists in chemical equilibrium with nitrogen tetroxide. Because NO2 is toxic, propellant handlers must be protected from exposures to hazardous levels. No reliable personal monitor to detect the presence of low NO2 levels in real time is currently available. A lightweight, real time detector is needed that provides an alarm when the time-weighted-average (TWA) concentration exceeds 500 ppb over any 15 minute period. The detector, therefore, must monitor 15 minute moving-average concentrations of NO2 over a work day. The detector must meet the following requirements:

SENSITIVITY - Register 90% of the final equilibrated response and recovery values within one minute for NO2 concentrations of 50 ppb.

RANGE: - 50 PPB TO 5 PPM

PRECISION/ACCURACY/LINEARITY - Over the 50 ppb to 5 ppm regime, the maximum output deviation from the ideal linearized output shall no exceed plus or minus 25%.

RELATIVE HUMIDITY EFFECTS - The maximum output deviation no to exceed plus or minus 10% over a relative humidity range of 20 to 80% and plus or minus 20% for 10 to 20% and 80 to 100% RH regime.

Phase I: Develop preliminary designs that emphasize not ony sensitivity, reliability, and size, but also operational costs.

Phase II: Optimize the sensor performance characteristics, fabricate and evaluate the prototype sensor, and field test the prototype detectors at an operational space launch facility. A fully engineered prototype device should be ready for commercialization upon completion of the Phase II technical effort.

Dual Use Commercialization Potential: A highly sensitive nitrogen dioxide sensor will have environmental monitoring applications such as automotive emissions and ventstack effluents from combustion sources.

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AF94-116TITLE:Fully Integrated, Low Cost "Programmable" PCM Encoder for Aerospace Use

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop a low cost, light weight Pulse Code Modulation (PCM) encoder that has the capability of providing 'on-board' data processing.

DESCRIPTION: New and innovative approaches are being solicited for the development of an integrated, low-cost (per unit) Pulse Code Modulation (PCM) encoder that has the capability of providing real time processing of the encoded data. Current encoders do not provide any on-board processing capability. This encoder should be programmable to meet both engineering and scientific needs. Programming can be done through a computer interface

or via firmware. Examples of programmable parameters should include, but not be limited to the following: type of output code; output bit rate--up to 2MBit/sec; word length 8 to 16 bits; number or words per frame; straight, super, sub and super-sub commutation capability; the ability to provide a data point to the PCM stream on a change only basis (for example, often parameters such as battery voltage or temperature are only of interest when they change, or go above or below a certain point); real-time signal processing algorithms (for example, there are times when raw data is of no interest and only the fourier transform, average, root mean square, etc., of the data is required).

IRIG-106-93 should be used as a reference. The output of the encoder must be range compatible. This encoder will be used in sounding rocket and other aerospace applications. The encoder should have the capability to withstand a high vibration, large temperature extreme environment such as seen during a rocket launch or aboard the Space Shutte. This does not preclude the use of commercial technology or parts. While radiation hardening should be a consideration, it is realized that it would come at a greatly increased cost. Radiation hardening is considered to be beyond the scope of a proposal of this nature.

Phase I: Phase I will provide a comprehensive and workable design, part selection and sample programming. The design should clearly show its flexibility and its low cost approach.

Phase II: Phase II will be the building and testing (both functionally and environmentally) of a working prototype.

Dual Use Commercialization Potential: As a rugged, robust piece of equipment, this encoder could find application in a variety of remotely-operated devices that must transmit telemetry, for example, robotic devices in certain manufacturing processes or environmental cleanup, scientific devices used for deep sea or volcano exploration. Potentially, such a device could also be useful in implementing various "smart highway" schemes for traffic flow control, toll collecting, etc.

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AF94-117TITLE:Light-Weight Control Moment Gyros for Small Robust Spacecraft

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Navigation, Guidance and Vehicle Control

OBJECTIVE: Develop compact light-weight control moment gyros for robust control of spacecraft weighing under 2000 pounds.

DESCRIPTION: New and innovative approaches are solicited for single and double gimballed control moment gyros that will assist in providing attitude control for spacecraft weighing up to 2000 pounds. The control moment gyros should provide an output torque and storage of an angular momentum that bridges the gap that currently exists between reaction wheels and control moment gyros (i.e., 2 to 10 foot pounds). Secondly, for both the single and double gimballed control moment gyros, it is desirable that only one and not a series of each will be necessary to bridge the gap previously described. Finally, these control moment gyros should be compact, light-weight, consume as little power as possible, and should have a reliability figure of 0.98 after 4 years. The intended use of these control moment gyros are to control small spacecraft (approximately 2000 pounds or less) which have a requirement to provide a rapid

maneuvering capability and compensate large unbalanced induced torques.

Phase I: Phase I will develop proof-of-concept approaches for single and double gimballed control moment gyros as described above.

Phase II: Phase II will be the design of the single and double control moment gyros which represent the best approach for each gyro as identified in Phase I.

Dual Use Commercialization Potential: Increasingly, researchers and certain commercial ventures (e.g., cellular telephony) are proposing work to be done in space. One major obstacle is the cost of access to space, which is often driven by launch costs and the size and complexity of spacecraft required. Often, space missions cannot be adequately performed by satellites without "3-axis stabilization;" however, the requisite stabilization systems, including reaction wheels and/or control moment gyros, have historically been either too large or not as accurate as desired. Development of the control moment gyros requested here will open the door to new applications, including precise remote sensing for small spacecraft. The potential market includes almost every spacecraft and satellite manufacturer.

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AF94-118TITLE:Space or Near Space Flight Experiments Demonstration Support Resources

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop innovative support systems and/or components for space or near space flight experiment demonstration which offer significant improvements over existing support resources.

DESCRIPTION: The Space Experiments Directorate is responsible for the development of a robust infrastructure to support the insertion of new technology into DoD and US space systems. Requirements to validate new technology through demonstration involve a variety of platforms to accomplish space and near space testing (e.g., high altitude balloons, high altitude aircraft, sounding rockets, free flying satellites, and captive space shuttle payloads). Our directorate is interested in any innovative developments in the following areas which can demonstrate significant improvements in ease of operation, cost of operation and acquisition, maximize where possible usefulness/synergy between the above platforms and payloads, mission tailorable, simplifying operation and maintenance, and high reliability (0.95 at 2 years mission duration for free flying spacecraft, 0.99 for all other missions, equipment and

software): data acquisition, coding and recording (non-volatile storage); attitude control subsystem and components; command and control subsystem; communication subsystem compatible with existing ground station protocols; electrical power subsystem; structural subsystems; thermal control subsystems; ground station systems; integration and test support equipment; experiment integration development aids (concept to finished product computer aided development system).

Phase I: Phase I will address the aforementioned systems and areas through superior design with as much ground work in analysis and test as possible. They will also clearly address the potential platforms supported by the proposed product, modular scalability of the product, the resulting benefits of the system (should address but is not limited to the above significant improvement issues above), and the approach to manufacturing and space qualifying.

Phase II: This program will construct and comprehensively test prototype products.

Dual Use Commercialization Potential: Topics in this broad area SBIR generally apply to making the use of space systems easier and more routine. Application of advancements in this area will allow greater access to space systems for universities and small firms than has previously been possible. Further, long-term application of these advancements may lead to space operations that more closely approximate today's use of airspace.

AF94-119TITLE:Avionics Research

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative concepts in areas associated with avionics hardware and software.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of avionics. Avionics meaning all electronics onboard an aerospace (missile, aircraft, or spacecraft) vehicle. The primary areas include: navigation; reconnaissance; electronic warfare; fire control; weapon delivery; communications; system architecture; information and signal processing; subsystem integration; and software research, development and support. Some examples of specific research areas are: non-cooperative target identification; airborne radar electronic counter-countermeasures; low-cost airborne radar; automatic tuning or adaptive parameter Kalman filters; hierarchical approaches for integrated resource managers; techniques for enhancing real-time avionics computer and software performance; covert radio/data link concepts; innovative global position system (GPS) application and estimation concepts; GPS wind profiling concepts; modeling and simulation approaches for signal level sensor as well as avionics subsystem and systems level investigations; and development of high-fidelity electronic defense simulators representative of threat radar systems. This topic is structured to provide a maximum of innovative flexibility to prospective participants. Therefore, as a part of the Phase I proposal, briefly describe the anticipated Phase II effort and the dual use commercialization potential.

AF94-120TITLE:Pattern Theory Extensions and Avionics Applications

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Apply pattern theory's robust pattern finding capability to solve avionics information processing problems.

DESCRIPTION: Pattern theory is an established paradigm which provides a robust characterization of patterns.

"Robust" is used in the sense that patterns of all types are included, for example numeric patterns, symbolic patterns, string-based patterns, and patterns in images. Recent research provides strong theoretical and empirical evidence that Decomposed Function Cardinality (DFC) provides a robust basis for pattern finding. Applications of DFC-based pattern finding are possible in many areas. However, application development has been hampered because current algorithms are limited to binary functions with a limited number of input variables and a single output variable.

Phase I: The goals of Phase I are to 1) identify innovative applications, and 2) determine the technical merit and feasibility of pattern finding algorithms to meet the requirements of these applications. These applications may require extensions to the current pattern finding algorithms. Examples of such extensions are 1) provisions for multiple output variables, a larger number of inputs, or multiple-valued input and output variables, 2) a treatment of objects that are not functions, or 3) the exploitation of prior knowledge about the pattern. The Phase I effort will also define approaches to developing any extensions necessary for the identified applications.

Phase II: Will develop the extensions identified in Phase I and demonstrate the resulting product in a specific application. The products of Phase II will include any extensions to the pattern finding algorithms, a demonstration of the extended algorithms in a specific application, and an identification of high payoff areas for further pattern theory extensions.

Dual Use Commercialization Potential: There are two routes that could be pursued. One route is to develop a general purpose software product that would address the need for more robust solutions in the rapidly growing market for computational learning packages. A second route is to use the Phase II results in a specific commercial application, such as logic minimization, computational learning, image processing, or data compression; any one of which has excellent dual use potential.

AF94-121TITLE:Target Recognition from First-Order and Second-Order Motion Patterns

CATEGORY: Basic Research

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop comprehensive test suite of first-order and second-order motion observed in image sequences.

DESCRIPTION: Current biological research has surmised that certain objects can be identified by the visual cortex of the primate brain based solely on their motion without additional knowledge such as shape and texture. This suggests that motion analysis could enhance current automatic target recognition techniques used by the Department of Defense. In order to test current and future motion analysis techniques, a comprehensive standardized test suite of image sequences which display first-order and second-order motion must be developed. But first, the research must identify as many categories as possible of first-order and second-order motion. Next, the research will develop algorithms to generate image-sequences that display the phenomena. Finally, the test suite will be developed.

Phase I: The contractor shall identify all categories of first-order and second-order motion. The contractor shall develop algorithms and/or techniques to generate image sequences which display the categories of motion. The contractor shall develop a limited suite of image sequences which display the categories of motion. At the conclusion of Phase I, the contractor shall deliver the limited suite of image sequences.

Phase II: The contractor shall implement the full test suite. The contractor shall demonstrate the validity of the test suite which must provide performance measures. The contractor shall test the full test suite against some of the commonly known motion analysis techniques such as spatio-temperal and spatio-temperal frequency techniques. A complete system for measuring the performance of motion analysis techniques will be the goal of Phase II. At the end of Phase II, the contractor shall produce and deliver the test system.

Dual Use Commercialization Potential: Dual use has been identified for the areas of optometry, biomedicine, psychology, robotics and automobiles. Vision specialists can use the motion test suite developed by this SBIR to evaluate patients with a form of motion blindness (Transitory Akinetopsia). Psychologists can use the motion test suite to evaluate the motion processing areas of a person's brain. Robotic engineers can use the test suite to test motion algorithms for robust vision systems. Automobile manufacturers can use the test suite for testing certain classes of

crash avoidance mechanisms that are image and motion based. Finally, biomedical specialists can use the motion-based object recognition to enhance analyzing biological image sequences such as image sequences of the moving heart.

AF94-122TITLE:Fire Control Fusion and Integration for Tactical Aircraft

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop fusion algorithms for tracking, sensor management, and weapon delivery for tactical aircraft operations.

DESCRIPTION: Recent advances in sensor technology and computer processing capabilities have begun to revolutionize tactical fire control. The ability to accomplish sensor management, multisource data fusion and internetted operations in tactical scenarios has greatly influenced weapon system capabilities and tactics. The ability to fuse data from various sources, such as on-board sensors and off-board assets, will lead to improved precision targeting and fire control solutions. Automatic target cueing systems can benefit from fused and electro-optic data, resulting in higher confidence and detection rates with lower false alarms. Enhanced aspect missiles could be employed using trackfiles derived from fused offensive sensors, defensive sensors, and wingman trackfiles. Within this broad area of fusion for tracking, sensor management and weapon delivery, there are two major areas we wish to focus on. The first area of interest involves fusion for air-to-ground precision targeting. Emerging inertial aided munitions will rely on on-board sensors and off-board assets to derive precision target locations. Algorithms that have the capability to integrate information from Forward Looking Infrared (FLIR) systems, Synthetic Aperture Radar (SAR), Inertial Navigation Systems (INS), Global Positioning System (GPS), and off-board information should greatly enhance the capabilities of attack aircraft. Specific areas of interest include the ability to direct, prioritize, and schedule available sensors, perform on-board fusion of information derived by the sensors and off-board assets, and utilize the fused information to develop an improved fire control solution. The second area of interest involves the integration and fusion of offensive sensors, defensive sensors, and wingman trackfiles to obtain the integrated picture of the environment and to coordinate these sensors throughout an air-to-air engagement. The algorithms should coordinate all functions performed by the aircraft: offensive, defensive, navigation, and threat assessment. The overall objective is automated all-aspect coverage by an integrated sensor suite enabling all-aspect weapon delivery. This capability will increase survivability, flexibility, and situational awareness while reducing pilot workload. Primary issues are conflicting timelines between different sensors, changing mission goals, latency of internetted tracks, and accuracy of fire control solutions. This program will build on recent advancements in enhanced aspect sensors, advanced missile control, datalinks, navigation systems, high angle-of-arrival radar warning receivers, and advanced warning systems.

Phase I: The contractor shall produce an algorithm design and implementation plan.

Phase II: The contractor shall implement the selected algorithms and perform detailed evaluation and demonstration of their performance.

Dual Use Commercialization Potential: Several areas for commercial Phase III efforts exist. Prime examples of these include air traffic control, automated manufacturing, multisensor robotics, remote surveying/exploration, and commercial satellite applications. The primary military application is information fusion for enhanced weapon delivery for Air Force tactical aircraft, however, the concepts developed would be applicable to a host of military multisensor platforms with varying missions like surveillance or reconnaissance.

AF94-123TITLE:Coherent Frequency Hopping (CFH) to Counter Anti-Radiation Missiles (ARM)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative waveforms for airborne radars that prevent acquisition and tracking by an (ARM).

DESCRIPTION: Conventional Doppler radars must operate on a single frequency for the coherent processing interval (CPI). The radar will transmit from 64 to several thousand pulses during the CPI which is typically on the order of 5 milliseconds. Operating on a single frequency for many pulses will facilitate acquisition by an ARM relative to a radar that can change frequency on each pulse. The key issue in CFH is to maintain the necessary pulse to pulse phase coherence that is required for subsequent Doppler processing. Some nonlinear CFH have been suggested in the past that have exhibited dynamic range and sensitivity penalties that were unacceptable. Linear CFH has not been extensively explored because of the increased RF and signal processing required. Modern monolithic RF components and digital processing technology may make these advanced waveforms technically feasible.

Phase I: Candidate nonlinear and linear CFH techniques will be compared analytically. The research will determine the performance and mechanization complexity. The configuration of a test radar that can be assembled primarily from standard test equipment will be defined.

Phase II: The test radar will be assembled, and the recommended CFH technique will be demonstrated.

Dual Use Commercialization Potential: CFH would allow commercial aircraft to utilize a radar as a collision avoidance, all weather landing aid and obstruction avoidance system, in real time.

AF94-124TITLE:Air-to-Air Combat Simulation

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a low cost simulation and modeling tool designed to evaluate beyond visual range air-to-air combat.

DESCRIPTION: A need exists for low cost simulations which enable analysts to quickly and easily evaluate various tactical scenarios. Improvements in the availability of high performance personal computers now provide the means to accomplish this objective. Work is however required to develop computationally efficient simulations which provide sufficiently detailed results. The simulation will model blue (friendly) and red (enemy) air-to-air radar performance as well as semi-active and active missile performance. The simulation will allow for user defined radar and missile performance inputs to model a wide range of systems. Detailed radar cross section will be input for both friendly and enemy aircraft (1^{o} Azimuth 5^{o} elevation bins). Engagement geometries will allow for pure pursuit and collision course intercepts at different speeds and altitudes. The software should be written to allow for the addition of other air-to-air sensors and weapons (e.g. IRST/IR missiles). The simulation should be menu driven and written to operate on a 486 based PC.

Phase I: Will define the general software architecture and development plan with sufficient detail to indicate a reasonable probability of success and an adequate description of the final simulation capabilities.

Phase II: Will use the approach in Phase I to develop the simulation and deliver to the government for evaluation

Dual Use Commercialization Potential: Commercial applications beyond a Phase II effort involve spinoffs of the simulation technology to other areas. The contractor will have developed a desktop simulation program with advanced windows applications, graphical user interfaces, and evaluation tools. Software of this type is very reusable on other programs and generic enough to apply to commercial areas. A specific instance would be the automotive industry where future changes to car models can be evaluated quickly while testing the impact of fuel consumption and wind drag. Design and testing of new commercial aircraft would also be an application. The primary military application is a desktop tool for rapid simulation of combat engagements with the ability to easily change parameters

and make new runs. This tool can be used for the evaluation of proposed weapon systems and upgrades, and their overall impact on the mission.

AF94-125TITLE:Enhanced Angle Estimation in Adaptive, Low Frequency, Radar Systems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Formulate and simulate innovative adaptive processing radar architectures for enhanced angle measurement accuracy.

DESCRIPTION: Adaptive radar signal processing technology has demonstrated the ability to enable target detection in severe ground clutter and jamming environments. The acquisition of low observable (LO) threats, by both ground-based and airborne radar systems operating in the VHF through L-Band frequency regions, in these difficult interference environments would not generally be possible at militarily useful ranges using conventional techniques. However, state-of-the-art adaptive sidelobe canceler (ASLC) and space-time adaptive processing (STAP) systems' target angle estimation accuracy can be degraded for two main reasons; 1) limited signal-to-interference ratios due to radar implementation and scenario factors including terrain scattered jamming interference entering the radar antenna's main beam and sidelobes, and 2) distortion of the adapted monopulse antenna patterns when encountering main or near-main beam jamming. These degraded radar angle measurement accuracies may be incompatible with achieving the required weapons systems fire control operations. Examples include the inability of a ground-based GCI radar to vector a fighter out to intercept a threat and achieving the air-intercept missile midcourse guidance that assures terminal guidance seeker target acquisition in light of the reduced seeker acquisition ranges associated with the LO threat signatures. Therefore, new adaptive processing radar architectures are being sought that afford the potential of measuring target range, Doppler, azimuth and elevation angles with the accuracies that are consistent with establishing track files for effective fire control.

Phase I: Will formulate and predict the performance, using digital computer radar and environmental simulations, of innovative adaptive processing approaches whose threat state space measurement accuracies are consistent with counter LO missile fire control. Low frequency linear arrays employing element and beam space configurations, ASLC, and STAP techniques are among the architectural features to be considered. For the airborne radar variant, an all target aspect angle capability (target's return competes directly with sidelobe clutter) is desired.

Phase II: Will formulate, design, and conduct a ground-based experiment that demonstrates the feasibility of the enhanced angle estimation architecture. It is envisioned that a real-time, passive radar (receive only) demonstration will be conducted using existing and/or modified Air Force and contractor adaptive processing hardware/software, instrumentations, jamming, and radar assets.

Dual Use Commercialization Potential: The state-of-the-art in digital signal processing, both algorithms and semiconductor electronics, is such that adaptive processing is rapidly becoming viable for commercial communications, navigation, and medical electronic systems. Application of adaptive processing technology to these electronic systems has already been demonstrated or proposed. This SBIR program will develop and demonstrate accurate radar target angle measurement technology and should find near-term commercial application in airport air traffic control radars that must operate effectively in difficult ground clutter and electronic interference environments.

AF94-126TITLE:Programmable Electronic Warfare Simulator Wide-Band Verification Instrumentation

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a programmable, real-time, wide-band, radio frequency receiver for EW threat environment simulation verification.

DESCRIPTION: Radio Frequency (RF) threat simulators generate dense threat environments to evaluate electronic warfare systems. The threat environments contain radar signals from 0.05 to 18.0 GHz with pulse densities greater than 1 million pulses per second (PPS). Current instrumentation systems use narrow-band tunable receivers and can only monitor preselected signals at preset times. Unexpected signals occurring outside the narrow-band receiver bandpass will not be detected. A wide-band receiver is required that can monitor the total frequency coverage (0.05 to 18.0 GHz) in a manner that will enable the detection of unexpected signals, pulsed Doppler signals, continuous wave signals, and low probability of intercept signals. The wide-band receiver signals must be software reprogrammable, capable of operation under computer control, and capable of accomplishing precision signal measurements in terms of carrier frequency, pulse width, pulse repetition interval, pulse amplitude, pulse modulation, etc.

Phase I: The contractor shall develop a preliminary design with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II.

Phase II: The contractor shall fabricate, demonstrate, evaluate, and document the proposed design. Along with the delivery of the system, the contractor shall provide recommendations for development and potential Phase III efforts.

Dual Use Commercialization Potential: This SBIR topic has dual use potential in the instrumentation industry. The basic system and architecture can be utilized in systems for electromagnetic interference/electromagnetic compatibility evaluations, for intercept and identification of transient signals, and for verification of commercial radar test environments.

AF94-127TITLE:Realistic Infrared Spectral Decoys

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop new concepts for countermeasure decoys which eliminate the undesired spectrum of decoy flares.

DESCRIPTION: Current pyrotechnic flares for decoying infrared heat seeking missiles have some radiations different than the targeted aircraft. In certain scenarios, this may make the aircraft more vulnerable to other threats. It is, therefore, desirable to develop a countermeasure which only contains the appropriate radiation to realistically simulate the infrared signature of the target aircraft. This effort will develop and explore alternative technologies, concepts, or methods for producing the realistic decoy.

Phase I: The contractor shall investigate the technical feasibility and practicality to generate such a reaction or process for this type of countermeasure. The contractor will determine the technical and physical phenomena involved and the important parameters necessary to generate the decoy. Through research and analysis, this effort will show what kind of new spectral decoy can ultimately be achieved with available technology.

Phase II: The contractor will work on implementing the technology into a feasible concept. Experimentation will be used to verify the analysis and to demonstrate the capability of the materials and mechanisms involved in generating a decoy. The contractor will make measurements showing the amount of infrared radiation that can be emitted with the proper radiation spectrum. The best concepts will be scaled to full size for testing. A demonstrated full size decoy concept will be the goal of Phase II.

Dual Use Commercialization Potential: A dual use phase of this effort will investigate and demonstrate the capability of the decoy for commercial applications. This may include law enforcement applications. The spectral

tailorability may provide infrared sources which can illuminate an area to enhance equipment used for night time infrared viewing by law enforcement officials or security personnel. Application of this technology may also aid commercial aircraft using an infrared imager to aid navigation during landing, take off, or taxing in bad or inclement weather.

AF94-128TITLE:Electronic Warfare Man/Hardware-in-the-Loop Real-Time Simulation Capability

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a reconfigurable, man/hardware-in-the-loop, real-time, electronic warfare simulation capability.

DESCRIPTION: The development of integrated defensive avionics technology requires a real-time, high-fidelity, man-in-the-loop/hardware-in-the-loop, simulation capability. Integrated defensive avionics use data fusion to provide real-time threat situation awareness and response strategy. The development of data fusion algorithms requires high-fidelity interface with the pilot, defensive avionics, and other aircraft avionics. In the laboratory, these interfaces are currently provided by linking real-time simulation capabilities such as the Integrated Defensive Avionics Laboratory (IDAL) and the Integrated Test Bed (ITB). However, these facilities primarily support other avionics technology developments not requiring linked operation and cannot be dedicated full time in the linked configuration. A reconfigurable high-fidelity electronic warfare man-in-the-loop/hardware-in-the-loop real-time simulation capability is required to cost-effectively and rapidly prototype defensive data fusion algorithms.

Phase I: The contractor shall develop a preliminary design with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II.

Phase II: The contractor shall fabricate, demonstrate, evaluate, and document the proposed design. Along with the delivery of the system, the contractor shall provide a recommendation for further development and potential Phase III efforts.

Dual Use Commercialization Potential: This SBIR topic has dual-use commercial potential in the entertainment industry. The real-time architecture can be utilized in systems transforming flight/combat simulations into virtual reality for home, arcade, and theme park use.

AF94-129TITLE:Interferometric Laser Warning Technology

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop interferometry concepts and a single aperture device which can effectively perform passive laser threat warning.

DESCRIPTION: Advances in laser-based weapons constitute a real threat to USAF fighter aircraft. A continuing need exists for a small, light, optically simple, passive system for pilot situational awareness and to pass threat information to countermeasure systems, both in near real time. Laser direction of arrival, wavelength, and pulse characteristics are desired for continuous wave and pulsed laser energy within the entire electro-optic spectrum. Detection of laser energy is desired for both direct illumination of the sensor as well as off-axis out-of-beam illumination of the sensor by scattered laser energy. Off-axis detection is a particularly difficult problem in that it requires extremely high sensitivity

and the distributed nature of the source confounds many coherency and direction of arrival techniques. In addition, the system must also have low false alarm rates, high probability of detection, and wide field of view. Special configurations of interferometry technology have the potential to solve the laser warning receiver requirements outlined above without being confounded by distributed sources. Particular emphasis should be placed on concepts that will allow detection of off-axis (out-of-beam) laser energy with at least quadrant DOA resolution and wavelength discrimination.

Phase I: This effort should generate an interferometric design concept and performance expectations for all sensor capabilities described above, including response time. Possible commercial applications/technology transition efforts should also be proposed.

Phase II: The second phase will proceed with actual hardware development, detailed performance measurements and actual delivery of an article for field test on jet fighter aircraft.

Dual Use Commercialization Potential: Commercial applications of this type of technology could possibly be developed for medical diagnostics, police surveillance, communications, manufacturing or process control, remote sensing, and environmental monitoring.

AF94-130TITLE:Distributed/Hybrid Cooling for Avionics Retrofits

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Design, develop, test, and demonstrate a distributed/hybrid cooling technique for existing aircraft.

DESCRIPTION: Avionics suites of existing aircraft (F-15, F-16, etc.) will be retrofitted with line replaceable modules (LRM) and integrated avionics racks (IAR). These LRMs contain the electrical, optical, and thermal interfaces for a given avionics function. Some of these modules will contain densely packaged electronics that require liquid flow through (LFT) cooling to remove the heat. Current aircraft electronics are cooled with air, either by conduction, or by air flowing over the devices. Next generation avionics such as on the F-22 are liquid cooled and LFT cooled. The air cooled systems are capable of cooing up to 25-watt modules. The liquid cooled systems can dissipate 50 to 70 watts per LRM and up to 200 watts for the flow through modules. In order to install new avionics on existing aircraft, a new cooling scheme that integrates existing air cooled systems with liquid cooled systems must be developed.

Phase I: Will include examining innovative cooling techniques, performing analysis (techniques, cost, manufacturability, aircraft performance impact, environmental control system impact, etc.), establishing a preliminary design, and creating a development plan for the chosen cooling concept(s).

Phase II: Will include the detailed design, prototype development, and testing of an appropriate-sized IAR with LRMs cooled by this novel concept. This will involve demonstrating the cooling of air cooled and liquid cooled LRMs in the same system configuration.

Dual Use Commercialization Potential: Will be considered/applied in all aspects of this effort. Current avionics in commercial aircraft are air cooled. As the electronics become more sophisticated, the packaging of these and, hence the heat load, become more dense, thus requiring liquid cooling. A distributed/hybrid cooling technique will solve commercial avionics thermal problems. Other dual-use areas to be considered include ground-based computers for large database systems requiring massive memory banks that generate large amounts of heat, automobile electronics/computers which have become very sophisticated and can take advantage of the existing liquid cooling within a vehicle, and commercial space applications that use advanced electronic technologies for navigation and guidance systems.

AF94-131TITLE:Concurrent Software Testing for Real-Time Avionics Systems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a more efficient, comprehensive software testing technique for real-time embedded computer software.

DESCRIPTION: Nearly half of the cost of developing embedded software is devoted to various forms of software testing. Software testing is performed both by the initial software developer and then later by each level in the development process. The testing procedure is accomplished by a progression of test environments, beginning with simulator debuggers, followed by software integration testing, then system integration testing, and finally flight test. The quality of the delivered software product, as well as its cost, is determined largely by the effectiveness of the software test process. In Science News June 6, 1992, pages 382-383, a possible new method of software testing was discussed. The main focus of the article is the evolution and definition of a new software paradigm described by Prof. Manual Blum: "At the root of these developments lies the startling notion of a probabilistic, interactive proof. ... this new technique relies on randomness and the interplay between a `prover' and a `checker' to achieve a practically unassailable proof." This software testing technique has been proven in a nonreal-time environment, but needs to be extended to complex real-time avionics software. There exists a potential for a dramatic increase in the quality of delivered software for military and commercial (Dual Use) avionics products. In addition, this research should result in a reduction in software development and maintenance costs.

Phase I: Will be an initial concept definition and the development of a plan to apply this technique to real-time avionics systems. These inputs will form a boundary for the determination of the framework to test this technique.

Phase II: Will be implementation of this technique for a specific test environment. The specific test environment would be based on a real world problem. In addition, the contractor will delivery a fully functioning demonstration version of the product developed in Ada.

Dual Use Commercialization Potential: Research in this area would apply to both military and commercial avionics software. Improvements in real-time software testing would benefit any user of avionics software as well as any user of real-time software.

AF94-132TITLE:Wideband Covert Airborne Radio (WCAR)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Telecommunications

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop, test, and evaluate a WCAR which uses very low cost, non-conventional, wideband noise waveform technology.

DESCRIPTION: Current conventional low probability of intercept/dection (LPI/D) and jam resistant spread spectrum communication systems are very expensive to develop and manufacture, and are susceptible to a wide range of potential enemy threats. This effort explores the feasibility of using non-conventional radio frequency technology and modulation techniques to develop a very innovative, low cost, jam resistant WCAR for multiple airborne data link applications. This WCAR can be used to covertly transmit Global Positioning System (GPS) position information from a wind dropsonde to a cargo aircraft and improve the drop master's ability to reliably hit the drop zone. It can also be used as a rescue radio for downed pilot location and communication, a covert beacon for drop site/plane crash location, a covert rendezvous and a refueling coordination radio by Special Operations Forces (SOF), a covert station keeping data link by SOF, and a covert situational awareness and coordination data by Air Combat Command (ACC).

Phase I: The contractor shall design a WCAR to satisfy both the wind dropsonde simplex data link requirement and an air-to-air two way communications and relative location requirement. The contractor shall also

analyzes the WCAR design to determine its theoretical performance and unit cost.

Phase II: The contractor shall develop, test, and evaluate two simplex transmit wind dropsonde WCAR terminals and four air-to-air two-way WCAR terminals, which were designed in Phase I.

Dual Use Commercialization Potential: This WCAR technology is directly applicable to the development of police, FBI, Drug Enforcement Agency, and other law enforcement agencies' radios. Joint commercial/government development and multi-service military development is highly probable for this phase.

AF94-133TITLE:Real-Time Carrier Phase Ambiguity Resolution for High-Dynamic Vehicles

CATEGORY: Basic Research

DOD TECHNOLOGIES: Telecommunications

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop real-time algorithms to resolve phase ambiguities for GPS measurements in high dynamic environments.

DESCRIPTION: Current P-code Ground Positioning System (GPS) receivers provide approximately 16 meter SEP accuracy when pseudorange measurements alone are used for positioning. Carrier phase tracking algorithms can produce position accuracies on the order of 3-5 centimeters assuming that the phase ambiguity can be resolved correctly. At present, this capability exists in real-time for static or low dynamic applications, but not for high dynamic environments such as a fighter aircraft may experience. In high dynamic environments, carrier phase tracking is not always maintained which prevents one from resolving phase ambiguities real-time to determine position accurately. This effort would develop real-time ambiguity resolution algorithms for high dynamic applications.

Phase I: The contractor would first develop algorithms for real-time ambiguity resolution assuming that carrier tracking is maintained. These algorithms would then be improved to perform real-time ambiguity resolution for the case where carrier tracking is lost for various periods of time. The algorithm performance shall be validated using high fidelity computer simulations, and, if applicable, actual data collected from flight instrumentation. An evaluation will be made of the computational efficiency of the algorithms. The contractor will provide documentation of all algorithm development details and performance results achieved.

Phase II: The contractor shall implement the real-time ambiguity resolution algorithms in Ada and using actual GPS hardware demonstrate their performance in a high dynamic environment. The validation of the algorithms will require the development of a highly accurate time, space and position information (TSPI) system capable of cm position accuracy and velocity of 0.01 fps. The developed TSPI will be applied in a series of flight tests to demonstrate the real-time performance of the developed algorithms.

Dual Use Commercialization Potential: These algorithms have tremendous commercial application in the areas of kinematic surveying, test reference for system validation, and commercial aviation. By developing a real-time cm position accuracy capability, surveys can be accomplished in less time resulting in a tremendous savings. Commercial aircraft can perform instrument landings, reduce airline block times, and reduce the size of safety corridors which will result in a savings of millions of dollars per year. Just as the commercial community has found the greatest number of uses for GPS, they too will benefit the most from this real-time capability.

AF94-134TITLE:Solid State Electronics Directorate Applied Research

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Explore innovative semiconductor, electro-optic, and electromagnetic materials and device technologies, and demonstrate concept feasibility.

DESCRIPTION: The following subtopics describe areas of the Directorate mission responsibility in electronics. This topic number and the specific subtopic letter must be identified and placed with the title on all related requests submitted to DTIC and on proposals submitted to WL/ELA.

A. RESEARCH: Explore revolutionary new device concepts and conduct feasibility demonstration efforts on devices with potential for high frequency microwave/millimeter wave, high-speed electronics, and electro-optical applications.

B. MICROELECTRONICS: Examine new device approaches to logic and electronic processing, ultra high speed digital switching devices, advanced semiconductor fabrication technology, high-speed/density integrated circuit packaging, power/thermal management techniques, computer based tools for electronic equipment design, and on-chip sensor/functional testability.

C. MICROWAVES: Investigate promising solid-state and thermionic devices, monolithic integrated circuits, power and low noise amplifiers, signal control components, transmit/receive modules, and advanced sensor concepts.

D. ELECTRO-OPTICS: Develop improved lasers and incoherent light sources, nonlinear optical devices and interactions, optical processing, beam deflection, modulation and control devices, detectors, and focal plane arrays.

Phase I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling, and measurements.

Phase II: Develop key processes, validate the model experimentally, explore critical parameters, and optimize the design.

Dual Use Commercialization Potential: Commercial applications that will benefit from innovative electron device technological
advancements include high temperature electronics for automotive and jet aircraft engines, optical sensors for environmental assessment, high speed digital electronics for computers and communication systems, automotive collision avoidance/warning sensors, and miniaturized diagnostics for the medical industry.

AF94-135TITLE:High Density, High Efficiency, Card Mounted Low Voltage Power Supply

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop 100-watt, 50-Vdc voltages, card mountable module and switching devices for high efficiency power conversion.

DESCRIPTION: An unacceptable condition is manifesting itself with the development of the new low voltage, high-speed, high density electronic technologies. The power supply will equal the volume of the rest of the subsystem, exceed the weight, and create unmanageable thermal and system response problems. To avoid this, future highly distributed power architectures must be developed in which power conversion occurs very close to the point of load, that is, on the electronic card. To date, it has not been possible to demonstrate a low voltage (< 5-Vdc) board mounted power module that can achieve an acceptable power volume/weight density and overall conversion efficiency while meeting the power quality requirements.

Phase I: Identify and analyze promising circuit topologies, device materials/structures, and packaging technologies to accomplish the proposed high density, high efficiency on-card power module.

Phase II: Design and fabricate prototype devices and/or power modules for characterization, test, and validation.

Dual Use Commercialization Potential: Commercial applications for high speed, low voltage semiconductor technology include power supply functions in computer workstations and microprocessor based consumer electronics.

AF94-136TITLE:Design Automation for Low Power Digital Electronics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop innovative design automation tools to produce minimum, low power dissipation electronic systems and components.

DESCRIPTION: The Air Force continuously develops complex electronic components and systems for its weapons. This topic seeks to develop software to perform the automated design, also known as synthesis, of complex electronics which dissipate a minimum of power to perform their design function. Low power digital electronic systems typically use techniques that minimize the capacitances and switching events necessary to implement their functions, employ static, complementary, low voltage tolerant, hot-clock, analog, and/or asynchronous circuit, topologies, and incorporate active power management circuits non-volatile storage, optimized output drivers, and optimized and power efficient clocking circuits. Application areas addressed should be those most relevant to Air Force systems, and the relevancy should be clearly described. This tool should be easier to use, produce a design much more rapidly than current methods, handle more complex designs, and yield a better optimized design. The technology to be developed should also be shown not to duplicate current off-the-shelf solutions. Inputs to the tool should adhere to standards such as VHDL (IEEE 1076) where possible and be reasonable and natural for the design application not the implementation. Outputs from the tool should be suitable for design analysis and for direct progression to the next phase of implementation.

Phase I: Phase I of this effort will accomplish the preliminary design of such a synthesis tool. Prototype application areas used for feasibility studies should be those most relevant to Air Force systems.

Phase II: Phase II will include the construction, testing,
demonstration, evaluation, and integration of tool into widely used electronic design environments. Reference manuals and user guides will be developed during testing.

Dual Use Commercialization Potential: Miniaturized high performance, low power electronics support commercial applications such as lap top computers, mobile communications, and digital personal assistants.

AF94-137TITLE:Bias Dependence Noise Modeling of Heterojunction Bipolar Transistors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop bias dependence noise models for heterojunction bipolar transistor devices.

DESCRIPTION: Recent advancement in heterojunction bipolar transistor (HBT) technology requires the need to develop sophisticated models for use in device/circuit analysis and design. At present, a majority of the HBT applications are optimized for power and efficiency rather than noise performance. However, there is a need to develop low noise transmitters and oscillators to support both radar and communication systems. HBT technology has demonstrated amplifiers with moderate noise and power performance along with high gain and linearity. Although HBT's have shown improvements over silicon bipolar transistors with regard to microwave noise performance, they are presently inferior to optimized Gallium Arsenide (GaAs) field effect transistors. Consequently, accurate HBT noise models will be required to support future device and circuit design. Much of the noise modeling has been focused on GaAs FET technology and silicon heterojunction bipolar transistors with little being done to apply it to HBT

technology. This program seeks to develop HBT bias dependence noise models which can accurately predict the physical mechanisms that generate noise in HBT devices.

Phase I: Investigate and develop heterojunction bipolar transistor physics based noise models.

Phase II: Evaluation and verification of noise models.

Dual Use Commercialization Potential: Commercial applications supported by low noise HBT transistor technology include wireless communication systems, direct broadcast communication satellite systems, and collision avoidance receiver warning systems.

AF94-138TITLE:Advancement of Multiple Quantum Well Based Infrared Sensors and Modules

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Optimize device structures and develop compatible readout multiplexers for III-V quantum well based infrared sensors.

DESCRIPTION: Quantum Well Infrared Detectors (QWIDs) show great potential as an alternative to HgCdTe long wavelength infrared detectors. Several issues must be explored in greater detail before the full capability of QWIDs is realized. As detector response is directly related to collection of photo-excited carriers, this process needs to be studied in greater depth. The details of carrier transport across the multiple heterostructure interfaces of the devices, and therefore collection of said carriers, is not understood. Models developed during Phase I shall handle at least five periods of a chosen structure, extending to the complete structure by the completion of Phase II. The final model shall allow specification of the detector structure, including material system, device temperature, applied bias, and whether electrons or holes are the charge carriers. Recent studies have revealed that materials other than n-type GaAs/AlGaAs may yield higher performance long wavelength devices. The material systems to be explored may be of type I or II band alignment and be electron or hole based. Because of the flexibility of quantum well design, it is not difficult to envision multicolor detectors. The multicolor response would consist of either several narrow bands within a single atmospheric window or one band in several windows. The first phase shall confirm absorption in at least two separate bands and show how readout of this information separately may be done. Demonstration of arrays with at least 64 by 64 spatially registered pixels, optimization of wavelength coupling, and maximization of detector fill factor shall be conducted during Phase II. A GaAs based readout multiplexer could potentially lead to a monolithic detector/readout multiplexer module. A design evaluation to identify charge capacity, bias range, and impedance requirements for a 64-by 64-pixel readout circuit with individual cell size of 50 um^2 shall be conducted. The resulting multiplexer shall be fully characterized at room and cryogenic temperatures.

Phase I: Material growth characterization and single detector characterization shall be completed.

Phase II: Growth of optimized structures, fabrication and characterization of detector arrays shall be completed.

Dual Use Commercialization Potential: Commercial applications for low cost infrared sensor technology include night imagery sensors for automotive industry, agricultural crop/soil assessment, and residential heating and cooling analysis.

AF94-139TITLE:Integrated Free-Space Based Optical Interconnect Research For Image Processing

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Investigate optical interconnect technologies and demonstrate best approach for specific image processing systems.

DESCRIPTION: For image processing system applications requiring high interconnection densities and/or fast data transfer, free-space based optical interconnects have several potential advantages over either electronic or integrated optics based interconnects. Free-space interconnects promise a higher bandwidth for increased throughput, ability to globally and arbitrarily interconnect 10,000 nodes per cm^2 for massive parallelism, a lower real estate requirement since interconnections are carried out in three dimensions, a lower power requirement and very high reprogrammability which can contribute to fault tolerance. For those signal processing system applications requiring lower interconnection densities and/or slower processing throughput, integrated optics may prove more advantageous because it is a much more mature technology and is proven compatible with electronic manufacturing techniques. This program will determine and demonstrate the trade-offs between integrated and free-spaced based optical interconnects for specific fault-tolerant, reprogrammable, real-time, image processing applications, including fast Fourier transform (FFT) accelerators for frequency component identification, wavelet transforms for detection of abrupt changes, memory transfer for fast or massively parallel processing and wavefront transformation for pattern matching. The prospective contractor should draw on existing electronic, microwave, opto-electronic, and integrated optical manufacturing and packaging technology during the
investigation. Integration with silicon (Si), gallium arsenide (GaAs) and/or practical multichip modules/circuit boards is required depending on the application. Emphasis will be on overall system performance and packaging to optimize processing speed, power and size requirements, fanout and packaging. This type of investigation has become feasible with the recent advancements in the implementation of free-space based optical interconnects. The proposed SBIR will provide the optimally designed interconnection architecture and a scalable implementation for specific real-time image processing systems before they get locked into a nonoptimized selection of an architecture and technology that would be difficult if not impossible to change later on.

Phase I: Determine the best interconnect technology between free-space and integrated optics for a particular image processing application and, at a minimum, demonstrate a few key elements of the better technology.

Phase II: Produce an optimized interconnect design and a scalable demonstration based on the proposed technology determined in Phase I.

Dual Use Commercialization Potential: Optical interconnect technology supports commercial applications such as high data transfer networks for cable and communication systems, and high data rate computers and parallel processors.

AF94-140TITLE:Nitrogen Source for Molecular Beam Epitaxy (MBE)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop appropriate nitrogen source for MBE growth of GaN and AIN for advanced electronics and photonics applications.

DESCRIPTION: The (Al,Ga)N system has great potential for applications in ultraviolet photonics, high power electronics, and high temperature electronics. However, the growth technology for producing high quality structures in this materials system has been slow in evolving. Although the molecular beam epitaxy (MBE) technique is the best method for producing many III-V structures, only metal organic vapor phase epitaxy (MOVPE) has produced (Al,Ga)N structures of device quality. Previous MBE attempts to produce device quality (Al,Ga)N films so far have largely been limited to electron cyclotron resonance (ECR) cracking of N_2, for supply nitrogen-containing species during growth. This approach is severely limited in capability, and an alternative nitrogen source is sought for use in MBE growth. Although the success of the MOVPE approach may be linked to the use of NH_3, as the nitrogen source, lower substrate

temperatures used in MBE suggest that precracking of NH_3, is necessary in MBE. An NH_3, cracker cell may provide high fluxes of a reactive nitrogen-containing species (e.g., N, NH, NH_2 but should not be deleterious to the MBE growth environment. Other nitrogen chemistries (e.g., triethylamine) should be considered for ease of obtaining reactive nitrogen species at the growth surface.

Phase I: Emphasis should be placed on (1) conducting a comprehensive literature search regarding the appropriate chemistry upon which to tailor the source, and (2) assembling a prototype source.

Phase II: The source would be further developed to become a commercially viable produce.

Dual Use Commercialization Potential: Commercial applications that will benefit from the development of economical, high quality semiconductor fabrication techniques include high speed electronic switches and electronic devices capable of operating in high temperature environment of jet aircraft and automotive engines.

AF94-141TITLE:Gallium Nitride (GaN) Materials for High Temperature Electronics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop semiconductor materials for electronic devices operating at high ambient temperatures.

DESCRIPTION: There is a great deal of interest in using semiconductor devices in high temperature environments. While the device operating principles essentially remain the same at high temperatures, the performance and reliability of electronic systems is reduced due to the degradation of device structure and intrinsic material parameters. The temperature dependency of intrinsic device performance comes from the basic semiconductor properties. The key parameters are the intrinsic carrier concentration, carrier mobility, and lifetime. The existing data indicate that high energy bandgap semiconductors are intrinsically more suitable for high temperature operations. In order to achieve higher operating temperatures than that of the most often used Si, larger bandgap semiconductors such as GaAs, AlGaAs, GaP, and SiC are being pursued. Preliminary results showed that GaN, which has even higher energy bandgap than those of the aforementioned semiconductors, is a promising candidate for high temperature applications. This effort is to develop the necessary technologies to demonstrate the viability of this materials system.

Phase I: Emphasis will be placed on developing a crystal growth technique for GaN.

Phase II: Focus will be on demonstration and optimization of materials growth and characterization, and device fabrication to verify its validity for high temperature operation.

Dual Use Commercialization Potential: Commercial applications for high temperature electronics include automotive, aircraft, space power stations, geothermal and oil well logging, and mainframe computers.

AF94-142TITLE:Flight Control Science and Technology

CATEGORY: Basic Research

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop flight control and technology to support air power projection and/or precision strike.

DESCRIPTION: Develop one or more of the following advanced flight control technologies for future aircraft: a) control effectors tailored for high efficiency transports, including laminar flow control, b) devices that facilitate stability and control testing of short take of vertical landing vehicles in ground effect, c) criteria for predicting pilot-induced oscillation, d) software for checking compliance with flying qualities requirements, e) fuzzy logic based aircraft flight

control, f) structural response feedback techniques for flight control, g) on-board system diagnostics concepts for highly integrated vehicle management systems, h) control system configuration for nonlinear and time varying flight conditions, i) real-time, high-fidelity multisensor image fusion software for piloted vehicle control.

Phase I: Exceptions include determining the feasibility, preliminary concept identification, requirements definition, and development of Phase II proposals. Some specific examples are the identification of several promising control effector concepts to move into testing, a complete survey and summary of existing Pilot Induced Oscillations (PIO) databases, requirements generation and development plan for PC based flying qualities software, and assessment and selection of one or two multisensor fusion techniques to move into testing.

Phase II: Expectations include hardware fabrication, ground testing, simulation or light testing, and validated, executable software code. Some specific examples are validated designs for one or two high efficiency effectors, simulation and possible flight test of PIO criteria, software development and demonstration of image fusion technique.

Dual Use Commercialization Potential: All of the items in this SBIR topic are equally applicable to the civilian and military aircraft sectors. The technology developed will provide for reduced fuel consumption for transport aircraft, reduced design and development costs for flight control systems, more efficient flight control system architectures, and the ability to operate aircraft in low visibility conditions.

AF94-143TITLE:Aircraft Drag Reduction Using Active Techniques

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Extend the range of military aircraft through the practical application of Active Drag Reduction Systems

DESCRIPTION: Aerodynamics drag is the major factor limiting aircraft range. Modern aircraft design practices tend to minimize the profile, induced and compressibility drag components by sizing the aircraft for specific mission needs. The friction and interference drag components are not as easily controlled in the design process; however, these drag components can be markedly reduced by the practical application of innovative active drag reduction devices. Recent skin friction drag reduction technology, such as the government sponsored laminar flow control flight experiments, have shown that the pneumatic control of aircraft skin friction drag can have a major impact on aircraft range improvement. The next big strides in skin friction and interference drag improvement can be made by linking microprocessors with aerodynamic boundary layer control devices to optimize flow control on or near the aircraft surface. The development and application of properly controlled active boundary layer and/or separated flow control devices offers the potential for dramatically improving the range of military aircraft. Also, the technology developed is directly applicable to commercial aircraft.

Phase I: Experimental demonstration of an active drag reduction device that will extend the range of military aircraft by controlling the aircraft boundary layer in a practical way.

Phase II: Active drag reduction device performance validation under simulation flight conditions.

Dual Use Commercialization Potential: Commercial aircraft industry. One of the highest leverage technologies in the competitive commercial aircraft development field is aircraft drag reduction. The US commercial aircraft industry has made great strides in building efficient transport aircraft by applying the latest passive drag reduction techniques to their current production fleet. Application of active drag reduction techniques, such as those to be developed under this program, offer new horizons in commercial aircraft performance that when properly exploited can lengthen the competitive edge our industry holds over commercial aircraft manufacturers throughout the world.

AF94-144TITLE:Affordable High Performance Airframe Concepts

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop innovative structures technology yielding affordable high performance twenty-first century aircraft.

DESCRIPTION: Significant advances in design and test methods, materials, manufacturing processes, and structural concepts for steady and dynamic states offer far reaching potential for achieving revolutionary advances in structures technology. Exploiting this potential is necessary to achieve long-term goals for reductions in airframe weight, development, acquisition, and operating costs, design margins, and structural responses while maintaining or increasing structural integrity, lifetime, supportability, survivability, and duality of application. Advances in technology are required for lightly to highly loaded and heated structures on operating and advanced high performance aircraft of the twenty-first century. Conventional, adaptive, and smart approaches are sought to aid in achieving goals.

Phase I: Should demonstrate a clear understanding of technical issues and should clearly explain the approach and its innovative qualities. Phase I will establish feasibility of proposed research and development using analytical and/or experimental techniques.

Phase II: Will concentrate on developing structures technologies shown feasible in Phase I.

Dual Use Commercialization Potential: High payoff structures technologies for military will have similar payoffs for commercial aviation and with innovative adaptation and modification may have payoffs in unrelated but structural situations.

AF94-145TITLE:Embedded Training Applications for the Bomber/Fighter Training System (BFTS)

CATEGORY: Engineering Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop and demonstrate embedded training methodologies and formats for the T-38 Advanced Trainer follow-on aircraft.

DESCRIPTION: As cockpits and the associated avionics become more and more complex, required training also increases. The cost for high fidelity training is great, and as a result, alternative approaches have been addressed. Simulation an ground based training devices are examples, but although effective, they lack the realism and stress of the aerospace environment. Embedded training incorporated into Undergraduate Pilot Training, especially into the T-38 follow-on, could allow for lower cost training of both the Head Up Display and the electronic Head Down Displays in the actual flight environment. Precision approaches, Electronic Warfare including threat recognition and response, Beyond Visual Range Air-to-Air, Air-to-Surface, and Traffic Collision Avoidance System are just a few examples of embedded training possibilities, with the Air Force seeing substantial savings in cost and training time compared to that required in the operational aircraft.

Phase I: Technical and economical feasibility of implementing an embedded training system into the BFTS, or follow-on aircraft.

Phase II: Proposed methodology and display demonstration of embedded training formats.

Dual Use Commercialization Potential: Commercial airlines, private aviation schools, Intelligent Vehicle Highway System (IVHS)

AF94-146TITLE:Affordable On-Board Fire Protection Concepts for Aviation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop new technologies and approaches in aircraft fire protection that significantly reduce life-cycle cost.

DESCRIPTION: Research in aircraft fire protection is currently very active due to the phaseout of ozone depleting Halon chemicals used as fire suppressants. Once chemical replacements are identified and implemented, further advances in aircraft on-board fire protection technologies will be difficult to implement in future aircraft applications. Fewer new aircraft will be built due to worldwide budget constraints, and existing aircraft already featuring fire protection systems will have extended service lives. New technologies proposed to replace existing systems on these aircraft must overcome initial substantial retrofit costs and unit costs to fare favorably in cost-benefit analyses. Recent advances in fire protection capability lessen the need to expand the fire suppression performance envelope as much as to provide lower cost of ownership for such protection. Life cycle costs for weapons systems and subsystems and the cost reductions new technologies provide will dictate which technologies will be retrofit in the future. This effort is thus oriented to identify and evaluate innovative concepts to provide lower life cycle cost requirements than currently required for existing aircraft fire protection requirements. These innovations can include modifications to existing maintenance and operational procedures, modifications to existing fire suppression and/or detection systems, or entirely new system components. These concepts will be technically evaluated based upon their low risk, life cycle cost savings and return on investment period, including the retrofit costs required. Low cost systems with minimal aircraft modifications will thus be heavily favored under such criteria. It is estimated that savings of 10% or more on life cycle costs may be sufficient to warrant retrofit actions in some applications. Rough estimates of life cycle cost reductions and return on investment period, with rationale and assumptions in the estimates included, shall be required in the proposals to allow proper evaluations and demonstrate technical competence.

Phase I: Phase I will consist of an evaluation of one or more proposed life cycle cost enhancements. Detailed life cycle cost and return on investment period analyses will be performed on each. Concepts will proceed into actual design of the systems for aircraft use, with performance and basic operational requirements included. A trade-off evaluation of these concepts will be completed based upon the life cycle cost and design studies, with a recommended approach. A mock-up non- or semifunctional demonstrator will be assembled if new hardware is proposed.

Phase II: The concept recommended in Phase I will proceed into full hardware design. Aircraft prototype hardware will be assembled and demonstrated for performance at Wright Laboratory test facilities. Additional demonstration tests for operational suitability shall be performed. If only a procedure is proposed actual field tests will be performed at an air base wing to validate the procedure.

Dual Use Commercialization Potential: These concepts would be expected to be directly attributable to commercial aircraft, which currently use similar fire protection systems to the military. If the cost benefit analysis results are favorable for commercial use and a sponsor is available, further implementation could be readily performed.

AF94-147TITLE:Infrasound as a Method of Bird/Aircraft Collision Reduction

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop an infrasound device to reduce bird/aircraft collisions by 50% within airfield boundaries.

DESCRIPTION: The USAF aircraft birdstrike problem is costly and long term: $45 million and 3000-3500 strikes a year since 1987, seven deaths since 1987, and three destroyed aircraft in 1992. 60.3% of USAF birdstrikes occur within the airfield environment (Hamershock 1992): takeoff, landing, final, downwind, and touch-and-go/missed approach.

Numerous methods are available to reduce these losses; however, the need for more innovative and effective methods remain. Infrasounds (sounds below 16 Hz) are emitted from natural sources such as mountain ranges, earthquakes, thunderstorms, auroras, and oceans (Kreithen and Quine 1979). It is hypothesized that birds use this sensitivity for navigational purposes. The possibility of ascertaining and reproducing natural avoidance responses of birds to mechanically replicable frequencies of infrasound may prove it as a potential method to substantially reduce the bird/aircraft strike hazard.

Phase I: Characterize the responses of samples of a gull species, raptor species, and waterfowl species to a range of infrasounds. Identify mechanically replicable infrasound frequencies which will invoke an avoidance response by at least two of the three species researched. An avoidance response will be defined as a response that behaviorally inhibits a bird species from physically inhabiting a previously enterable or desirable location, leaving the treated location free from species penetration. Identify levels of habituation of tested species to the repulsive infrasound frequencies.

Phase II: Prototype design, fabrication, and demonstration of capability of efficiently and effectively producing the avoidance response frequency(ies) for field testing. Conduct field tests validating a 50% or greater reduction in airfield bird populations and aircraft birdstrikes. Determine environmental effects of infrasound on other airfield operations and inhabitants.

Dual Use Commercialization Potential: The potential users of an infrasound bird repulsion device are many and include: All branches of the military, airfield managers, biologists, pest control/maintenance employees, government agencies (the Federal Aviation Administration, the US Department of Agriculture), agri-/aquaculturalists, aircraft manufacturers, and homeowners.

AF94-148TITLE:New Primary Flight Controllers

CATEGORY: Basic Research

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Explore new primary flight hand controllers for both transport and fast jet aircraft.

DESCRIPTION: The fly-by-wire control laws allow for a wide choice of primary flight controllers; however, the stick, yoke, and throttle remain the standard in transports and fast jets to achieve flight and thrust control. Technological advances as well as the desire to keep the pilot's hands on the throttle and stick (HOTAS) have led to the addition of other types of controls on the stick, yoke, and throttle, such as designation control and communication control. The trend to keep adding to the current flight controllers has led to a lack of investigation into new types of hand controllers. New controllers may be better suited to provide the pilot with primary flight control as well as the additional functionality offered by the current stick, yoke, and throttle. This effort will focus on designing new types of primary flight controllers.

Phase I: This phase will focus on the design of at least six new and innovative possible flight controllers. An investigation will be conducted to determine their applicability to perform the military mission. Criteria will be identified for the evaluation of the candidate controllers. Examples of these criteria might include visual access, physical access, precision of control, learning, and overall suitability. An overall assessment of how these controllers satisfy the criteria, and a final ranking of the candidate controllers will be completed.

Phase II: The phase will require the contractor to build at least three of the top primary flight controllers from Phase I. Implementation of these devices into government test facilities will also be required. Testing will be conducted by the government.

Dual Use Commercialization Potential: Commercial aircraft for flight control, computer applications for hand control of specific functions, video games, automobile industry for vehicle control, and train industry of vehicle control.

AF94-149TITLE:Flight Control and Networked Simulation

CATEGORY: Engineering Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop innovative flight simulation technologies to support precision strike and long haul simulation research.

DESCRIPTION: The Air Force is interested in innovative new flight simulation technologies which will advance the state-of-the-art in long haul networked simulation in support of precision strike weapon delivery research. Research in the area of improved network simulation fidelity, capability, or in cost reduction for simulator hardware on a network are of particular interest. The Distributed Interactive Simulation (DIS) standard is the desired baseline for any research in the area of networked simulation; however, improvements in implementation of the standard, or in variances of the standard which will improve performance are highly encouraged. Emphasis is desired in the area of simulation quality between multiple players on the network. Novel display technologies, lower life cycle cost simulation techniques, or improved techniques for conducting research using networked simulation are also sought. Innovative approaches for the use of large high Definition Television (HDTV) aspect ratio Cathode Ray Tubes (CRTs) in flight simulator instrument panels, or multiline rate video insetting techniques for generation of instrument panel imagery is of interest. Improvements will be considered for any technology, hardware device, or software program which shows potential for flight simulation advancement.

Phase I: The Phase I effort shall define the proposed concept, investigate alternatives, and predict performance of the proposed design. Demonstrations of high-risk portions of the design are encouraged, but not required. A final report shall be submitted summarizing the results of all analyses and comparing the performance of alternatives.

Phase II: Phase II shall fully implement, demonstrate, and test the Phase I design. Results of the tests and recommendations for improvements and/or alternatives shall be documented.

Dual Use Commercialization Potential: Improvements in flight simulation technology typically have application with some modification to flight simulators used by the airline industry to satisfy FAA training requirements. Advancements to low cost simulators can be applied to private pilot training simulators.

AF94-150TITLE:High-Strength Damage-Resistant Foam Cored Composites

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop lightweight cored composite structures that inherently possess high-strength damage-resistant qualities.

DESCRIPTION: The Air Force has a continuing goal to reduce the weight and cost of aircraft structure while increasing damage resistance and tolerance. Sandwich structure (or cored composite) is a leading concept for weight reduction. The majority of sandwich structure on Air Force aircraft involves a honeycomb core with adhesively bonded facesheets. Although lightweight, conventional cored composites are not only costly to fabricate, and inherently vulnerable to a variety of environmental threats. Microflaws allow moisture laden air to enter and condense within the part. Internal corrosion, together with frequent disbonds between skin and core, lead to drastic performance changes for parts which are either stiffness critical or have dielectric functions. As a result, repair and replacement of these honeycomb components are frequent. There is a need to develop a durable, low cost, weight competitive alternative to adhesively bonded honeycomb sandwich structure. Organic foam cores can be molecularly bonded to the

skins and therefore eliminate the cost and weight associated with relatively weak adhesive bondlines. Some concepts allow for fabrication of the entire sandwich component in onestep. This not only eliminates the need for expensive machining, but results in a part which is dimensionally perfect. The closed-cell nature of organic foam cores precludes moisture absorption and corrosion. Foam cores and stronger skin-core interfaces also have the potential for significant improvements in impact resistance. Although foam cores demonstrate several desirable qualities (all leading to reduced R&M requirements), their shear and compression properties are not presently weight competitive with honeycomb. Overcoming this deficiency is the goal of this program. To make foam cored composites weight competitive with honeycomb composites, the density of current foam has to be reduced from present levels to as little as 6 to 11 lbs/ft3. This must be achieved while maintaining specific shear strengths of 60 to 80 psi/(lb/ft3) under hot/wet conditions of 250.F and 95% relative humidity.

Phase I: Composite sandwich structures of various concepts (having thicknesses ranging from 0.25 to 1.00 inch) will be fabricated, environmentally conditioned (to include solvents), and subjected to shear and compression tests. Goals of the effort will be weight gains (due to moisture absorption) of less than 1% while maintaining strength requirements under hot/wet conditions.

Phase II: Composite sandwich structure concepts having acceptable properties and minimal weight gains (as identified in Phase I) will be scaled up and subjected to advanced environmental, strength, damage resistance, and damage tolerance testing. The goal of the effort will be to identify concepts which meet R&M 2000 requirements.

Dual Use Commercialization Potential: Foam cored composite materials are suitable for nearly any commercial application where structural rigidity is required. Typical examples are primary and secondary aircraft structures (to include floors, doors, and radomes), automobile components (the frame, body, and gas tank), truck beds, boat hulls, and equipment housing.

AF94-151TITLE:Active Attenuation of Aircraft Vibration via Smart Structures

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Demonstrate the use of "Smart Structures" technologies to attenuate vibration in aircraft structures.

DESCRIPTION: Dynamic response of aircraft structures are a concern in aircraft design. Smart Structures technologies have demonstrated vibration attenuation on laboratory test articles. Using active materials (e.g., piezoelectric, magneto-restrictors, or shape memory alloys), the response of a structure to external disturbances can be controlled. The application of this technology to aircraft structures will improve performance and reduce life-cycle costs. Possible applications include twin-tail buffet, acoustic cavities, active pylons for electronic pods, and active isolation of electrical equipment or sensors. Innovative concepts are sought which address these or other aircraft structural dynamic problems.

Phase I: Analytical demonstration of feasibility for full-scale aircraft structure and Phase II test article.

Phase II: Experimental validation on a representative laboratory test article and preliminary design for the Phase III flight test article.

Dual Use Commercialization Potential: Suppression of vibration and acoustic problems in a wide variety of commercial products such as electronics equipment, where vibration decreases component life, automobiles, where acoustics and vibration are both a rider comfort and component life problem; and the machine tooling industry, where chatter-free tooling operation would allow more exact tolerances at faster cutting speeds. Additionally, the commercial airlines will benefit from reduced vibration and acoustic problems.

AF94-152TITLE:Adaptive Cockpit Error Monitoring System

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Provide for the detection, correction, and prevention of pilot errors in the cockpit.

DESCRIPTION: Pilots can only endure a finite amount of physical and mental workload during missions before human error becomes a concern. Human errors can occur when workload exceeds a threshold, the pilot is fatigued or bored, as well as several other situations. Those human errors in the cockpit have caused the loss of life as well as significant investments in equipment. This work will categorize and prioritize the full range of potential and probable errors that may occur in cockpits. Also, current mechanisms that identify and correct problems on today's aircraft will be examined. This will facilitate the development of an intelligent system for the detection, correction, and prevention of aforementioned errors in the cockpit.

Phase I: The research will begin with identification and classification for a full range of potential cockpit errors. Additionally, the currently fielded mechanisms for the prevention and correction of errors will be examined. Phase I will culminate in a strawman architecture for preventing, correcting, and predicting pilot errors.

Phase II: Will implement the intelligent system architecture developed in Phase I. The software will be validated and verified during Phase II. The goal of Phase II is a prototype error monitoring system to be applied to cockpit aviation.

Dual Use Commercialization Potential: The immediate commercial market is the civilian air fleet. However, such an error monitoring architecture would benefit any application where human error plays a significant role in potential loss of lives or property. Nuclear power operations, air traffic control, and ground transportation would be top candidates for such an error monitoring system.

AF94-153TITLE:Precision Cargo Airdrop Methods for High and Low Altitudes

CATEGORY: Basic Research

DOD TECHNOLOGIES: Unassigned

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop innovative concepts for the precision airdrop delivery of cargo from high and low altitudes.

DESCRIPTION: Airdrop methods have changed very little since World War II. While computer technology, global positioning systems and advanced parachute designs such as parafoils have increased the accuracy of delivery, these methods are costly and leave room for improvement. Cargo airdrop accuracy and cargo aircraft vulnerability are concerns of both the Army's combat ground forces and the Air Force. Airdrop delivery in both war time and peace time demands a far greater accuracy than is achieved by conventional methods.

Phase I: Will provide novel, unconventional, cost effective concepts other than parachutes to accurately deliver air-dropped supplies from high and low altitudes. The design goal for accuracy is a delivery error of less than 100 meters.

Phase II: Will develop a prototype system for test and evaluation by the Army and Air Force. The candidate system for Phase II shall be chosen from those concepts developed in Phase I.

Dual Use Commercialization Potential: Accurate aerial delivery of cargo has numerous applications to disaster relief as well as military operations. A company that developed this technology would be in a good position to provide systems to both the government and private sectors.

AF94-154TITLE:Behavior Modeling of Anisotropic Composites

CATEGORY: Engineering Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop modeling techniques to characterize the behavior of anisotropic composite materials.

DESCRIPTION: The mobility requirements of the Air Force often lead to operation from minimal facilities referred to as bare bases. Shelter systems for these facilities have to be sufficiently lightweight to be air transportable and still provide a measure of attack resistance. Design of these shelters will require innovative materials and geometries. Candidate composite materials currently being researched are highly anisotropic due to material properties or complex geometric configurations. Material characterizations are needed for use in structure analysis and design methods.

Phase I: Phase I will be the development of numerical material modeling methods in three-dimensions for composite materials that exhibit anisotropy due to material or geometric characteristics. This information will be in a form that can be used for structural design with the material.

Phase II: Phase II will expand on Phase I effort by formulating constitutive materials models that will quantify the material behavior for use in computer based analytical methods.

Dual Use Commercialization Potential: The software would have marketing potential as an analysis and design tool to any industry utilizing composites.

AF94-155TITLE:Voice-Activated Poor Visibility Emergency Response System (VAPERS)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop a voice-activated poor visibility emergency response system for improved fire protection response.

DESCRIPTION: A voice-activated poor visibility emergency response system (VAPERS) capability will facilitate faster, safer travel to emergency crash fire incidents during night and adverse weather, and provide at least a 90% increase in the ability to sense people, vehicles, and debris at an emergency site. This technology, intended principally for night and adverse weather response, will also enhance daytime response. System components support a wide variety of operational scenarios usable during both nighttime/adverse weather and daytime firefighting incidents. The system will overcome the inability of vehicle operators using vehicle headlight and high intensity lamp technology to see through flames, smoke, and fog. The ability to 'see' will give the vehicle operator significantly increased operational capability. The system will utilize a variety of advanced display and electronic systems which interface to navigation, audio and video sensors. Additional capabilities are required to meet the mission needs of modern crash fire rescue vehicles including a requirement for a data link and a mission and display system to provide enhanced situational awareness for the Fire Chief, Communications Center, and each individual vehicle.

Phase I: Phase I of this work will include mission analysis, preliminary design, proof of technical feasibility, an assessment of operational requirements, and selection of hardware and software concepts for Phase II development.

Phase II: Phase II of this work will include hardware and software development for the voice-activated system and the communications data link, and the development of stabilized platforms for sensors and displays. Phase II also includes the integration of existing fire department communications systems and the demonstrated performance and a single operational system installed and validated at a major forward operating location, qualification of integrated hardware and software designs, validation of selected concepts, and the integration of the concepts into qualified hardware and software.

Duel Use Commercialization Potential: Each Federal, State and local air field installation where commercial

and military aviation is under control of an active control tower represents a potential customer.

AF94-156TITLE:Refuse Derived Fuel Power Generation System

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a power generation system using paper trash, garbage, used tires, and nonhazardous used POL and motor oil for primary fuel source and other conventional fuel for secondary source.

DESCRIPTION: Air Force installations generate a significant amount of waste that is often disposed of via contract, adding considerably to the base O&M budget. A cost-effective means of utilization that will allow full destruction of base generated waste is required to minimize this expense and meet fuel requirements for power generators. This research effort will include the development of generator adaptor kits to convert existing power generators into a refuse derived fuel power generator. Increasing concerns for environmental protection, operational cost reduction, and installation sustainability dictate the requirement for better methods for providing base power needs while addressing these issues. Funds normally spent on fuels such as coal, diesel, and other petroleum-base fuel will be greatly reduced as these fuels are substituted with waste by-products. Reduction in solid and liquid waste management costs are anticipated due to a decrease in landfill operations and processing costs for waste liquids.

Phase I: Deliverable will be a concept of operation to include details on suggested design, component specifications, and estimated cost and payback for a typical Air Force system.

Phase II: Validate concept through prototype construction and test.

Dual Use Commercialization Potential: Waste management and electrical power utility.

AF94-157TITLE:Machine Recognition and Removal of Fusing Mechanisms in Explosive Ordnance

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Automate the recognition process for fusing mechanisms that have been partially obligated in explosive ordnance.

DESCRIPTION: Part of Explosive Ordnance Disposal (EOD) range clearance operations is to identify ordnance and remove it from a test range intact (to determine its failure mode). In performing this operation, it is desirable to remove the man from the location of the ordnance and to automate some of the process of removal. A critical element of the removal process is to remove the fusing mechanism from the ordnance. To accomplish this in an autonomous manner, it is necessary to recognize the physical characteristics of the fuse so that a mechanism for removal may be applied through an articulated platform (robotic arm). The recognition process should identify the fusing mechanism to such an extent that the mechanism characteristics for removal from the ordnance is known. The mechanism for removal of the fuse should take the form of an end effector for an articulate platform and should be able to assume the necessary physical characteristics to perform the removal process. A system that can recognize the physical characteristics of the fuse, transfer this information to a system controller, and then remove the fusing mechanism is desired. Since the Enhanced Excavator for EOD Range Clearance Project has existing capabilities for imaging, electronics, and software development, it is desirable that the developer either make use of these resources as government furnished equipment or adhere to the hardware/software standards set by the program.

Phase I: Will determine the method and means of accomplishing this task and identify the necessary hardware and software development. Deliverables or a preliminary software design and demonstration of the recognition process and a graphic simulation of the proposed end effector design.

Phase II: Will proceed with the development and deliver a prototype of the recognition system and end effector. The contractor should perform testing of the prototype system to quantify its abilities.

Dual Use Commercialization Potential: Deliverables could be used by a municipal or state police force and any type of small parts manufacturers that deliver small quantity unique items.

AF94-158TITLE:Carbon Thermal Management Components

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop high-temperature conductivity materials by reducing minimum gauge, low-cost fibers, and high-conductivity matrices.

DESCRIPTION: Electronics in both DOD and non-DOD applications are advancing at a very rapid rate. Effective implementation of the advancements requires enhanced thermal management. Particularly, increasing high-density electronic component packing, high electrical power requirements, high resolution sensor equipment, and on-board cooling creates an ever increasing need for efficient thermal flow. Future ground, air, and space vehicles will require advanced materials to save weight and maximize thermal performance in electronic packing, battery sleeves, and radiators. Personal computers to the most advanced space systems can benefit from low cost approaches to enhance thermal management through increased thermal conductivity. Materials with an extremely high specific thermal conductivity are desirable. Novel concepts using the high thermal conductivity of carbon are encouraged. In order to be a viable material of choice, the state of the art must be advanced in the following areas: (a) minimum thickness plies; (b) low-cost, high-conductivity, high-strength, weavable fibers; and (c) high thermal conductivity densification methods.

Phase I: Phase I will consist of parametric studies and modeling behavior with small coupon level articles produced.

Phase II: Phase II will continue for the most promising Phase I concepts.

Dual Use Commercialization Potential: The potential of the technology in this topic has vast implications for dual use and commercialization in electronics for consumer, business and miniaturization purposes. The ability to package efficiently from a thermal management standpoint can have far-reaching effects in virtually every application of electronics.

AF94-159TITLE:Highly Parallelized Software for Atomistic Materials Properties Simulations

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Generic

OBJECTIVE: Discover and code new parallel algorithms for atomistic, molecular level calculations for new organic materials.

DESCRIPTION: Investigations are sought to formulate, implement, and verify new efficient parallelized approaches for molecular

simulations. Areas of emphasis include investigation into (a) Hartree-Fock and (b) correlated, post-Hartree-Fock molecular orbital calculations, (c) molecular mechanics based molecular dynamics simulations, (d) density functional approaches to molecular electronic and geometric structures including optimizations and dynamics, and (e) time dependent variational Hartree-Fock approaches. Focus is on optical, nonlinear optical, electrically conductive, and transport property predictions, with attention given to incorporation of the latest advances in global optimization techniques. Target hardware for implementation will range from multiprocessor workstations to massively parallel systems.

Phase I: The establishment of technically and commercially viable approaches to obtaining advanced software for designing improved nonmetallic materials are sought in Phase I efforts which can be pursued in Phase II follow-on efforts.

Phase II: Phase II will entail software development, implementation, verification, and commercialization assessment, as well as commercial development plan.

Dual Use Commercialization Potential: Phase III efforts would transition functional software for full commercial development and subsequent enhancement of materials development programs for electro-optics organic materials which could be widely used in the civilian industrial sector including telecommunications, signal processing, and computations.

AF94-160TITLE:Environmentally Compliant Low Observable Coatings

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop low/zero-VOC materials and/or application techniques suitable for low observable aircraft coatings.

DESCRIPTION: The Air Force is interested in the research and development of aircraft coatings with a minimal detrimental impact on the environment. Of primary interest are aircraft coatings for low observable applications. Specifically, the coatings should address signature control in the visible, infrared, and radar bands of the electromagnetic spectrum. Most conventional coating application systems currently in use produce substantial organic solvent emissions. Some include toxic, noxious, or other smog producing components. New materials and/or application systems that can greatly reduce or eliminate these VOCs (Volatile Organic Compounds) and other undesirable materials are necessary in order to comply with stringent environmental regulations, either currently in effect or likely to be enacted in the near future. Relevant technologies for low/zero-VOC coating development include, but are not limited to, high solids coatings, waterborne coatings, powder coatings, plasma/thermal spray systems, and appliques. Innovative materials, such as binders, pigments, thin films, and their suitability for use in these types of application systems are also of interest.

Phase I: Phase I will address initial formulation, fabrication, evaluation, and application techniques of specific subjects for proof on concept.

Phase II: Phase II will further develop and optimize the material and/or application techniques, and produce larger samples for a full spectrum of evaluations.

Dual Use Commercialization Potential: The requirement to comply with environmental regulations applies equally to the commercial coating industry. As such, much of the technology developed for compliance of military coating systems could be extended to commercial applications. Opportunities for commercialization in the solar energy field also exist. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an
environmentally compliant and commercially viable application technique.

AF94-161TITLE:C01AF4Environmentally Compliant Solvent Substitutes for Chlorofluorocarbons

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop environmentally compliant replacement solvents for chlorofluorocarbons.

DESCRIPTION: The Air Force is interested in the research and development of environmentally compliant solvents to replace the currently used chlorofluorocarbon solvents. Chlorofluorocarbon solvents are widely used as solvents in the maintenance and repair of mechanical equipment for Air Force systems and ground support equipment. They are effective, fast drying, non-toxic and
nonflammable. All of these properties have led to their wide-spread utilization throughout DOD and commercial industry. The
chlorofluorocarbon solvents are ozone depleting chemicals and are being phased out of production for environmental reasons. New solvent materials are required to serve as environmentally compliant replacements. They must have as many of the attributes of the chlorofluorocarbons as possible, but be in compliance with stringent environmental regulation, either currently in effect or likely to be enacted in the near future. Some of the key environmental considerations are: ozone depletion potential, toxicity and biodegradability.

Phase I: The Phase I effort will address the feasibility of the approaches proposed to achieve the goals of the program.

Phase II: Phase II will further develop and optimize the materials or process demonstrated in Phase I and produce larger samples for more complete evaluations.

Dual Use Commercialization Potential: The potential application of the technology addressed in this topic has wide spread applicability to non-DOD manufacturing, processing and equipment overhaul facilities. The new solvents are required to replace the chlorofluorocarbons which have become the industry standard in most commercial processes, etc. because of their excellent solvency, nonflammability and ease of drying. The potential for commercialization of the replacements being developed under this topic is extremely high because of the high volume requirements for these solvents both in DOD and the private sector.

AF94-162TITLE:Halon Replacement for Aviation Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop environmentally compliant replacement materials for Halon for Aviation Systems.

DESCRIPTION: The Air Force is interested in the research and development of environmentally compliant replacements for Halon as a fire extinguishing agent for use in military and commercial aircraft. Halon is currently used as a fire extinguishing agent due to its inherent quality to evacuate the oxygen from an area, thereby removing the fuel source of the fire. Halons, as well as other man made emissions, such as chlorofluorocarbons, carbon tetrachloride, and methyl chloroform are known to be contributors to ozone depletion. Stratospheric ozone depletion leads to an increase in the amount of harmful ultraviolet radiation reaching the earth's surface. New fire suppression materials must be developed which utilize the current principals for fire suppression by evaluation of their performance at the molecular level. This can be accomplished through the investigation of the methods of molecular dissociation and recombination of halons in an oxygen rich environment. The materials must meet the requirements for compatibility with current systems while minimizing their contribution to ozone depletion. By December 31, 1995, the US will end production of all ozone depletion chemicals. The AF will need to measure selected materials effectiveness and develop a prototype

replacement within this time to avoid a price increase as existing stockpiles are depleted.

Phase I: Phase I will address initial evaluation and formulation of specific subjects to achieve the goals of the program.

Phase II: Phase II will further develop and optimize the materials or process demonstrated in Phase I and produce larger samples for more detailed evaluations.

Dual Use Commercialization Potential: There is clearly a commercialization potential for non-DOD aircraft and dual use potential as a fire suppression method in applications where high value assets (e.g., electronics, computers) must be protected form destruction by fire.

AF94-163TITLE:High Temperature Structural Materials for Advanced Air Force Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop and characterize advanced high temperature structural materials.

DESCRIPTION: New approaches are requested to develop and characterize (a) advanced high temperature structural ceramic composites (2500 degrees F to 4000 degrees F, excluding carbon-carbon composites), (b) intermetallic materials and composites (2000 degrees F to 3000 degrees F, excluding nickel aluminides and discontinuously reinforced titanium aluminides), and (c) model forming process for advanced structural materials. For ceramic composites, research is limited to continuous ceramic fiber reinforced ceramic matrix systems and may include the following: (a) new, unique ceramic composite development; (b) fiber/matrix interface treatments engineered for toughened behavior and stability; (c) continuous ceramic fiber development; (d) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain etc.) as a function of temperature and loading history; and (e) analytical modeling of composite behavior. For intermetallic materials, research is limited to (a) new or novel methods for synthesis and processing of composites for intermetallic alloys which emphasize achieving theoretical density, low defect and interstitial content, and low synthesis temperatures; (b) methods for modeling intermetallics and intermetallic composites which lend insight into chemistry selection and control as well as microstructural selection and control; (c) methods of fabricating composites to provide chemistry and microstructural control on submicron scale while maintaining the ability to vary and control the final microstructural scale; and (d) methods for environmental protection of intermetallic composites aimed at providing long life under cyclic oxidation conditions. For modeling of forming processes research may include modeling of (a) the unit forming process; (b) the material behavior in response to the demands of the unit process; (c) the interface between the work piece and the die of mold; and (d) novel methods for obtaining physical property data and constitutive equations for insertion into models.

Phase I: This program will focus on the critical issues which when solved, will provide proof of concept.

Phase II: This program will be structured to develop and refine those feasible concepts to the point where an assessment could be made of the ultimate potential to help meet Air Force advanced materials needed.

Dual Use Commercialization Potential: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchangers, and power turbines, are also pertinent.

AF94-164TITLE:Aging Systems Nondestructive Evaluation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop new nondestructive inspection/evaluation techniques for aging aerospace systems.

DESCRIPTION: Advanced innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques for the detection, imaging, and characterization of flaws and other integrity-reducing anomalies in aging flight vehicle and engine components. In particular, innovative technical approaches are needed for (a) the detection and characterization of metal corrosion in hidden/inaccessible airframe locations before significant materials loss has occurred, (b) the detection and characterization of cracking/multisite damage in metallic airframe structures, and (c) the detection, imaging, and characterization of surface and bulk anomalies in metallic and nonmetallic airframe structures or engine components. The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have problems of a very similar nature to those faced by the DoD. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factory and/or Air Force Air Logistics Center inspections, or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the clear potential for ultimate use in realistic manufacturing or in-service environments.

Phase I: This program will address the initial formulation, fabrication, and evaluation of specific NDI/E techniques for demonstration of proof of concept.

Phase II: This program will perform enhanced development for optimization of the NDI/E techniques investigated in Phase I.

Dual Use Commercialization Potential: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have problems of a very similar nature to those faced by the DoD.

AF94-165TITLE:Biotechnology for Nanostructures, Electronic, and Optical Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Apply biotechnology to obtain novel processes or materials to solve AF problems.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of biotechnology to aerospace and commercial requirements. Such programs should address the fabrication of materials with compositions and/or microstructural morphologies of such complexity that they are only obtainable through natural processes. The study of this area could conceivably lead to the development of lower energy processing and materials with very specific electronic and electro-optical properties and contain very few microstructural anomalies. Since biological materials often perform several functions with ease, an investigation of the trade-offs involved in natural material systems could lead to design philosophy for multifunctional materials with, for example, both electro-optical and structural properties.

Phase I: In Phase I, programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, fabrication, and evaluation required for proof of concept.

Phase II: In Phase II, the process or design concepts from Phase I would be developed through optimization and scale-up efforts to establish feasibility for manufacture. Either process or design concepts would lead to a marketable product after a Phase III program.

Dual Use Commercialization Potential: Dual use of this exploratory research is foreseen for new materials for optical storage of information and for other microelectronic devices, micromachines, the inspection of many types of

structural and electronic components and for the development of new high performance polymers.

AF94-166TITLE:Epitaxial Growth of Silicon Carbide (SiC)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop advanced, innovative epitaxial processes for the growth of silicon carbide for electronic applications.

DESCRIPTION: Advanced Air Force systems will require new and novel semiconducting materials to meet challenging power, frequency, speed, and temperature requirements. Conventional semiconductors such as bulk silicon and gallium arsenide cannot meet these requirements. Silicon carbide has many interesting properties such as wide band gap, high breakdown field and physical strength, which make it attractive for high temperature and high power applications. This task seeks to develop new and innovative approaches for the growth of epitaxial silicon carbide. All polytypes are of interest as well as alloys of heterostructures of silicon carbide with III-V semiconductors. While homoepitaxy of SiC to bulk SiC is of primary interest, growth on new substrates will be considered. The offeror is reminded that this is a materials task and projects that are primarily device development or device processing will be considered nonresponsive.

Phase I: Phase I will address process development and initial testing to show proof of concept. Modeling studies of growth processes or materials properties are appropriate. A deliverable of a representative test sample to the government is encouraged.

Phase II: Phase II will develop the advanced semiconducting material or process to demonstrate the potential application. Modeling studies of growth processes or materials properties are appropriate. Deliverables of test materials to the government for testing is encouraged.

Dual Use Commercialization Potential: Microwave devices made from SiC will exhibit high power, high frequency operation (e.g. 20 watts in X-band at room temperature) with higher package density and reduced cooling subsystem requirements. In addition, the high temperature nature of SiC permits the development of a host of harsh environment electronic devices. SiC electronics have many commercial applications. The automotive industry needs reliable materials and devices for the high temperature, corrosive, dirty environment in an automotive engine. Additionally, one of the planned uses in military aircraft, namely, on-engine flame detectors (i.e. in the engine during flight) is directly transferrable to civilian aircraft. The development of improved epitaxial growth processes for SiC will be required for the successful commercialization of these high temperature, high power devices.

AF94-167TITLE:Nonlinear Optical Materials

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop nonlinear optical materials with superior properties as compared to those presently available.

DESCRIPTION: Nonlinear optical (NLO) materials are required for a variety of Air Force applications including electro-optic
countermeasures, LIDAR, laser radar, optical signal processing, and optical interconnects. These applications require new laser sources (optical parametric oscillators and harmonic generators) and electro-optic devices (directional

couplers, guided-wave
interferometers, and spatial light modulators). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts must address material issues for inorganics or organics in either bulk form for optical wavelength conversion or thin film form for electro-optics. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only for the purpose of evaluating and demonstrating the properties of the material(s) as a minor part of a materials effort.

Phase I: The objective is to demonstrate the proposed growth or processing techniques.

Phase II: The objective is to develop advanced nonlinear materials and relevant processes to demonstrate potential.

Dual Use Commercialization Potential: Materials technology is fundamental to all applications, military and commercial. Examples of commercial applications for NLO bulk crystals are LIDAR for environmental monitoring, medical lasers, and scientific instruments. Examples for NLO thin films are optical interconnects for electronic chips and packages, switching networks for communications, and automatic object recognition systems.

AF94-168TITLE:High Temperature Superconducting Materials

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop processes for fabricating high temperature superconducting thin films and multilayers for electronic and opto-electronic applications.

DESCRIPTION: High temperature superconducting (HTS) materials offer a variety of application opportunities. For example, higher performance microwave circuits, improved infrared sensors, higher density interconnects, and faster signal processing can potentially be achieved. The properties of the materials and interfaces must be controlled in order to fully utilize the value of HTS technology. Development of unique thin film deposition and processing methods for fabrication of superconductor-insulator multilayers, for fabrication of SNS or SIS junctions, or for hybridization with other electronic technologies are examples of topics considered appropriate for this program area. This topic addresses the development of thin film processing techniques, particularly for fabrication of multilayered structures and junctions, and investigation of the
superconducting/non-superconducting material interface.

Phase I: Phase I will address process development and initial testing to demonstrate proof of concept. Delivery of a representative test sample or samples to the government is encouraged.

Phase II: Phase II will develop and optimize the process or material to demonstrate the potential application. Delivery of material samples to the government for testing is encouraged.

Dual Use Commercialization Potential: HTS materials technology has great potential for dual use and commercial applications. For example, SQUIDs made using HTS junctions can be used for biomagnetic imaging and for many different nondestructive evaluation applications. Passive millimeter wave components fabricated with HTS thin films offer significant savings in weight and size for commercial communication satellites. HTS materials may also be used in commercial electronics applications to provide improved multichip modules and faster signal processing.

AF94-169TITLE:New Rigid-Flex Printed Wiring Board Materials

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop new materials for rigid-flex printed wiring boards.

DESCRIPTION: All the currently available materials used in rigid-flex printed wiring boards have difficulties in meeting performance requirements for military applications. New materials based on organic or inorganic materials are required. Current Air Force avionic hardware has experienced failures which degrade system performance. Problem areas include bonding polyamide and glass epoxy laminates with polyamide flex material and copper foils and being able to survive temperature cycling from -54 degrees C to 125 degrees C without voiding or breaking loose or causing barrel cracking. Current acrylic, epoxy, polyamide and fluoropolymer adhesives each have trade-offs and shortcomings depending on intended applications. Current epoxy adhesives limit flexibility, acrylics melt at 40 degrees C, polyamides have low bond strength to polyamide films; and fluorocarbons are generally dimensionally unstable during soldering. The current adhesives make it difficult for boards to pass thermal stress tests. Voids and adhesive failure develop due to differences in thermal coefficient of expansions and moisture absorption.

Phase I: Phase I should examine existing adhesive/flex system materials, modification of materials, and the potential development of new materials. This effort should examine the feasibility of obtaining identified materials and provide a discussion on their potential advantages over existing materials.

Phase II: A Phase II effort would characterize selected materials and evaluate finished rigid-flex-rigid printed wiring board constructions for use in military avionic systems.

Dual Use Commercialization Potential: The commercial electronics industry is starting to realize that multilayer flex and rigid-flex can offer unique, sophisticated solutions to the ever increasing demand on real estate within an electronic package. In turn, the rigid-flex industry is attempting to re-adjust to the competitive arena of the commercial marketplace and to prepare for the anticipated commercial demand and market growth. Driven by the same density, performance and packaging requirements that the military and aerospace markets have demanded, the communication and information markets are in need of the packaging solutions rigid-flex and multilayer flex can offer.

AF94-170TITLE:Characterization of Latent Defects in Avionic Hardware

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop techniques for characterizing latent defects in avionics hardware.

DESCRIPTION: Technology advances are required in electronic failure analysis and material characterization in order to develop reasonable failure free operating periods for avionic equipment. The level of reliability achieved by most deployed avionics is significantly less than desired by the user, producer, and developer. Additionally, avionics is becoming the driving force for flight safety. Identifying and characterizing latent defects in electronic assemblies and components is of primary interest. Technology areas of specific interest include printed wiring boards, integrated circuits, and hybrid microcircuits.

Phase I: A Phase I effort should determine the feasibility of identifying a manageable number of defects which are associated with one or more of the identified technology areas. Justification for selecting a given defect should be discussed. Materials behavior and failure analysis experience should be used to discuss how the identified defects can result in hardware failures.

Phase II: A Phase II effort would design and conduct experiments for evaluating latent defects and determining their life limiting characteristics. The environmental conditions necessary to stimulate the failure mechanism associated with the defect would also be evaluated. Methods of reducing the occurrence of given defects and minimizing their effects is the overall goal.

Dual Use Commercialization Potential: Techniques developed from this program would be directly applicable to general commercial aviation and the automotive industry. Developed technique will improve long-term reliability and lower losses by reducing subassembly failures.

AF94-171TITLE:Material Property Discovery

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Generic

OBJECTIVE: Investigate the application of neural networks, genetic algorithms, and associative memories to material modeling.

DESCRIPTION: Currently approaches to modeling materials include, depending on the profiles of interest, calculations from first principles, continuum models, and macrobehavior models. The massive computation requirements in terms of time and therefore cost significantly limit the usefulness of these approaches. Further, although progress is being made, the widespread application of these approaches is precluded because of the difficulty in applying quantum mechanical equations to materials of engineering interest. An alternative approach would explore experimental data to discover patterns that can be used as predictors of mechanical,
crystallographic, and thermodynamic behavior. Neural nets, genetic algorithms, and/or associative memories facilitate such an approach.

Phase I: In Phase I, investigations will be accomplished to determine the utility of neural nets, genetic algorithms, and/or associative memories in modeling materials. Materials of immediate interest include high temperature intermetallics, composites, electro-optical semiconductors, and polymers.

Phase II: Phase II will continue the investigation of promising discovery approaches, emphasizing their application to specific materials. Phase III will develop a few modeling approaches in detail sufficient for widespread application in the materials community.

Dual Use Commercialization Potential: Dual use of this exploratory research is foreseen for process design of microchips and other microelectronic devices, machining and inspection of structural parts, and design of high performance metals, ceramics and polymers.

AF94-172TITLE:Intelligent Control Systems for Hot Forging and Extrusion Processes

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Generic

OBJECTIVE: Develop advanced control systems for hot deformation of high temperature materials.

DESCRIPTION: A hierarchical control structure based on quantitative and qualitative techniques has been formulated for intelligent control of deformation processes. This methodology for advanced process control employs design axioms and is derived from material behavior and process models. The independence and information axioms are employed to conceptually design the control structure of a given deformation process. The primary deformation processes of interest include the following: forging of TiAl turbine blades, forging of TiAl integral blade and rotors, and forging of TiAl composites.

Phase I: In Phase I, an advanced control strategy involving the identification of required process control technologies will be developed using the control structure and methodology described above. Some intelligent control

technologies of interest may include scientific techniques from flight control, flight mechanics, optimization and material science for representing the nonlinear transient material deformation.

Phase II: In Phase II, a prototype control system will be designed and built for at least one forging or extrusion process. The capabilities of the advanced control strategy to improve product will be validated and demonstrated for practical forging shapes using the available material data. Phase III will develop intelligent control systems for widespread application to hot forging and extrusion processes.

Dual Use Commercialization Potential: This program has a wide range of possible dual use applications in metal forming, especially for commercial aerospace, automotive engine, and land based turbine industries.

AF94-173TITLE:Advanced Distributed Control Technology for Turbine Engines

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Investigate and develop, robust, fault tolerant, distributed control architectures for advanced technology turbine engines.

DESCRIPTION: State-of-the-art control system architectures that rely on centralized control are rapidly reaching performance limitations as the number of engine control variables continues to increase on advanced turbine engines. Damage tolerance, processing speed, maintainability, and development cost are major deficiencies for centralized control systems. Distributed engine control represents an innovative approach to solving the ever increasing performance demands on the engine control system. Advances in smart actuators, high temperature electronics, fiber-optic communication, and high-speed buss architectures make feasible the development of a high-speed, robust, fault tolerant distributed engine control architecture.

Phase I: The Phase I program goals are to develop a fault tolerant, distributed engine control architecture that is readily transitionable to the turbine engine community. Issues such as distributed architecture performance trade-offs, reliable communication, sensor technology, sensor integration, and smart actuator control authority will be explored.

Phase II: In Phase II, a simulation of the proposed architecture will be conducted. Hardware will be developed and bench tested in a Phase III effort. This will ultimately lead to extended engine testing of the developed system.

Dual Use Commercialization Potential: Distributed control technology has application in commercial aircraft, commercial aircraft engines, as well as industrial process control. Additionally, maintainable, fault tolerant control system architectures, developed to handle increasingly complex control and diagnostic applications could find application in many commercial ventures such as, petroleum refining, ground based gas turbines, and marine power plants. In all of these applications, high speed, data intensive, robust, control and communication is important.

AF94-174TITLE:Compression System Design Methodology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop enhanced and advanced compression system and secondary-flow design methodologies.

DESCRIPTION: This is to be achieved by numerous theoretical and experimental efforts including such work as

computer modeling, cascade testing, bench rig tests, etc., all adequately documented to be acceptable to the technical community. A major trend in compression system hardware is the increased utilization of low-aspect ratio blading, solid or hollow blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two-dimensional must be extended fully into three dimensions to adequately exploit these trends. Adequate documentation of this work and its influence on turbomachinery is needed as a comprehensive background document on turbomachinery. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, forced response and mistuning in compression systems, secondary flow design, time unsteady features of the turbomachinery gas path, and secondary flow systems. Areas of particular interest in secondary flow design include counter-rotation, trenching, brush seals, and disk pumping in regions as far back in the engine as the turbine shroud area.

Phase I: Phase I will result in concepts for the development of enhanced and advanced compression systems and methodology for secondary flow design.

Phase II: Phase II will result in software compatible with Wright Laboratory systems dealing with advanced compression system and secondary flow design.

Dual Use Commercialization Potential: All commercial gas turbine engines require compression and secondary-flow systems. The improvements gained in compression and secondary-flow system performance and efficiency will therefore directly benefit commercial turbine engines helping United States engine manufacturers to maintain superiority in the global commercial engine market. Performance and efficiency gains would also translate into monetary savings for commercial airlines by reducing fuel consumption.

AF94-175TITLE:Further Development of Innovative Concepts for Turbine Engines

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Evaluate feasibility of known innovative concepts for future turbine engine applications.

DESCRIPTION: Fulfill the Phase III and subsequent objectives of the Integrated High Performance Turbine Engine Technology Initiative (IHPTET), further development of many already identified innovative concepts is necessary. There is a need to analyze and further evaluate the significant potential of each of the selected concepts and, from the evaluations, prioritize for their real potential to meet ultimate IHPTET goals. Weight-saving concepts such as magnetically compressed rotors, life cycle cost concepts such as intelligent engine monitoring systems, combuster concepts such as combining diffuser, and dome and environmental concepts such as Ozone production from gas turbine engine exhausts and airborne production of hydrogen are just a few typical candidates.

Phase I: Phase I work will require identification, selection, and technical evaluation of a host of concepts using facts and data already available. The majority of the technical effort will be put into the evaluations, the results of which will enable the concepts to be prioritized with respect to their potential to IHPTET, their compatibility with other advanced materials systems and concepts already selected for IHPTET and their practical, as opposed to theoretical, feasibility.

Phase II: Phase II work will then be focused on demonstration of the critical technology of the most attractive concepts identified in the Phase I effort, so that they can then be transitioned into the IHPTET program.

Dual Use Commercialization Potential: This deliberately broad-based program would have considerable impact on the commercial market. Many, if not all, of the already known innovative concepts would be relevant to commercial engine design or operation, as the common thrust in pursuing the innovations would be to improve efficiency, capability, or performance of gas turbine engines. This program thus offers great scope for dual use.

AF94-176TITLE:Engine Diagnostic, Trend Monitoring, and Life Management System

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Design of an air-carried diagnostic, trend monitoring, and life management system for gas-turbine engines.

DESCRIPTION: The Integrated High Performance Turbine Engine Technology Initiative (IHPTET) will widely use advanced materials and innovative concepts; it will also demonstrate a significantly greater power and performance capability than any previous gas turbine engines. A comprehensive engine diagnostic, trend monitoring, and life management system is therefore warranted to not only detect incipient failures within the engine but also to routinely perform diagnosis of engine faults and accurately compute life consumption of critical components. The end aims of the system would be to increase engine life on the wing, obtain the maximum safe life from the engine and its components, and to minimize ground maintenance.

Phase I: In Phase I, a paper design of such a system will be carried out with possibly a computer model demonstration. Extensive use will be made of artificial intelligence, neural networks, and any other appropriate emerging technology. The model will also be generic so that it could be easily adapted to any gas turbine engine.

Phase II: In Phase II, a full-scale system will be built for installation on an Advanced Turbine Engine Gas Generator (ATEGG) or a Joint Technology Demonstrator Engine (JTDE).

Dual Use Commercialization Potential: The program is directly applicable to all commercial gas turbine engine operators in both the aircraft and power generation industry. The commercial payoff in the fields of maintenance, life optimization, life cycle costs and safety would be significant and would equate to the benefits which would be enjoyed in the military sector. The potential success of this dual-use technology would, in essence, revolutionize the management of gas turbine engines for all applications. Moreover, because the civil and military use of the proposed system would be identical, there is opportunity to physically standardize the system for any engine, as the only difference would be the installed data and software specific to the particular type.

AF94-177TITLE:High Mach Combined Cycle Engine Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop key technologies for combined cycle engines operating from Mach 0 to 6 flight speeds.

DESCRIPTION: Investigations of combined cycle propulsion systems have shown turboramjets and air-turborockets to be very attractive propulsion concepts at Mach 0 to 6 flight speeds. Both concepts combine the flexibility and efficiency of turbomachinery at flight speeds of Mach 0 to 4 with the simplicity, low weight, and high specific impulse of the ramjet in the Mach 3 to 6 flight range. Currently, plans are underway to develop technologies for both a turboramjet and an air turborocket under the High Mach Turbine Engine Technologies (HiMATE) program. Under this program, technologies which would be applicable to either cycle are of primary interest. The proposal must demonstrate an understanding of the HiMATE program and its goals. Examples of technologies which are of interest include air intake systems, exit nozzles, solutions to reduce the length and weight of the inlet and nozzle components, ramburner structures, ramburner fuel injection/flameholding schemes, endothermic fuel reactor/engine integration, heat exchangers using either fuel or a nonexpendable fluid to cool air, ramburner cooling techniques and air driven power generation devices. Proof-of-concept testing is preferred, but analytical investigations will also be considered.

Phase I: The goals of Phase I will be to identify a novel concept, quantify its payoff, and conduct a small-scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis

must be performed to demonstrate some degree of concept feasibility and plan experiments for Phase II.

Phase II: Larger scale development would be undertaken in Phase II. The proposal should include plans for Phase II testing, which include identification of appropriate facilities. The goals of Phase III would be to integrate the components developed in Phase II into a combined cycle engine demonstrator and evaluate its performance.

Dual Use Commercialization Potential: Combined Cycle Engines have application to a multitude of vehicles which require efficient acceleration and cruise capabilities. Military application might include long-range, high-speed aircraft for reconnaissance and strike missions and for stand-off missiles. Commercial application might include high-speed civil transport or passenger aircraft similar to the concepts under study by NASA Lewis Research Center. Dual use, military/commercial, recoverable space launch vehicles show promise of greatly reducing the cost of placing payloads in orbit and require airbreathing propulsion for the initial boost phase. Both the PEGASUS launch vehicle and the National Aerospace Plane could benefit from the use of airbreathing boost propulsion.

AF94-178TITLE:Combined Cycle Propulsion System Exhaust Nozzle Instrumentation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop advanced instrumentation techniques to measure temperature and species profiles in combined cycle engine exhaust nozzles.

DESCRIPTION: Recent mission studies have shown attractive payoffs for Mach 4 to 6 combined cycle propulsion systems using hydrocarbon fuels for both commercial and military applications. A number of component technologies need to be developed for such propulsion systems, the most critical being the exhaust nozzle. The nozzle will have to operate over a broad range of temperatures and pressures and accommodate expansion ratios as high as 40 to 1. The high temperatures associated with Mach 6 flight lead to dissociation in the combustor, and the lack of recombination of the exhaust products in the nozzle can result in losses in overall performance. Studies have shown that a 1-percent drop in gross-thrust coefficient can result in an 8-percent reduction in net thrust and a significant rise in vehicle takeoff weight. Accurate measurements of temperature and velocity profiles and recombination rates in Mach 4 to 6 nozzles are needed to upgrade kinetics codes and develop design methodologies for high performance exhaust nozzles. Although a number of instrumentation techniques have been and are currently being developed to measure temperatures, velocities and species, these technologies have generally not been applied to Mach 4 to 6 exhaust nozzles at realistic operating conditions. Under this program, innovative advanced instrumentation systems are sought to measure temperatures, species, and velocities profiles in supersonic exhaust nozzles operating at conditions commensurate with Mach 6 flight speeds. Emphasis should be on obtaining data useful for kinetics model development. Both nonintrusive and intrusive techniques for use in a test cell environment rather than a bench top basic research experiment are of interest.

Phase I: The goals of Phase I will be to analyze and demonstrate the feasibility of the proposed system in a small-scale experiment.

Phase II: The goal of Phase II would be to install and demonstrate the proposed system in Wright Laboratory's High Mach Advanced Propulsion Research Facility, Test Cell 22, Building 18. Measurements will be taken in an existing research water-cooled combustor/nozzle system designed for continuous operation at high pressures, temperatures, and levels of vibration. In Phase III, the technology developed would be marketed by the small business for use by the Aerospace community.

Dual Use Commercialization Potential: Combined cycle engine exhaust nozzles have application in commercial high-speed transport planes as well as the first stage of a commercial space-launch system. Additionally, instrumentation techniques developed to measure species and velocity profiles in a high temperature environment could find application in many commercial ventures such as pollution control, chemical processes, and the nuclear industry. In all of these processes, accurate measurements of exhaust products is critical.

AF94-179TITLE:Monorotor for Air Turborocket (ATR) Engine

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Design, analytically evaluate, and develop a low cost demonstration of a monorotor ATR.

DESCRIPTION: Promising to combine the efficiency of turbojets in the Mach 0-4 range with the high specific impulse of ramjets in the Mach 3-6 range, the ATR could power a supersonic, fast-strike weapon or boost a transatmospheric vehicle. Past ATR research has proposed the novel concept to use a turbocompressor monorotor composed of fan blades outside to the central ring and of turbine blades inside to the central ring. This monorotor concept could propel an ATR more efficiently due to potential weight and volume savings and more economically due to simple injection-molding manufacturing. The program demonstrates the viability of a monorotor-powered ATR and determines its operating conditions/limitations.

Phase I: Phase I would include as many of the following tasks as possible: literature search to ascertain previous relevant work; conceptual design of a monorotor ATR, and determination of its operational envelope; recommendation of an easy-to-handle and environmentally-clean (possibly solid) propellant; illustration, including weight and dimension estimates of all key ATR components, showing integration of monorotor in the ATR; computer cycle prediction of the monorotor ATR performance; survey of possible materials (metals, ceramics, and composites) used to manufacture the monorotor and bearings; preliminary harmonic (Campbell diagram) and vibratory stress analysis (Goodman diagram) to verify design integrity; test plan development for Phase II work.

Phase II: Phase II work would include a more in-depth analysis to accomplish these tasks and the fabrication, spin testing, and fuel-powered operation of a suitable monorotor for the ATR. This effort should be a simple and low cost demonstration of the monorotor ATR over the defined performance envelope. The demonstrator ATR could be a subscale prototype but should maximize usage of "off-the-shelf" components. The demonstrator must include the monorotor, combustion chamber, fuel delivery system, nozzle, and a means to start and to throttle the engine. The demonstrator should potentially average a minimum specific impulse (thrust/fuel massflow rate) of 600 seconds throughout the envelope.

Dual Use Commercialization Potential: The potential success of this dual-use technology would revolutionize turbocompressor manufacturing for both the military and commercial sectors. A new commercial product (innovative turbomachinery) easier and cheaper to make would show its worth. Several commercial applications are foreseen. Wright Laboratory and NASA have both studied the benefits of ATRs for powering a Pegasus-type vehicle to deliver satellites into orbit. A monorotor ATR would dramatically increase the payload capability of this commercial vehicle. Furthermore, flying hobby vehicles and commercial drones would also be powered by this more compact and cheaper engine. Thus, this innovative technology could aid military propulsion needs and could spin-off to benefit the propulsion requirements of commercial industry.

AF94-180TITLE:More Electric Aircraft Power System Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Explore and develop electrical components and devices applicable to future and retrofit "more electric" aircraft.

DESCRIPTION: Proposals should address technologies important to the electrical power system of a more electric aircraft. Under the more electric aircraft concept, troublesome hydraulic, pneumatic, and mechanical subsystems are replaced with a highly reliable electrical generation, distribution, utilization, and energy storage system. Key technology barriers which must be overcome are fault tolerance, thermal management, electrical control and regulation, electromagnetic compatibility, and fault detection.

Phase I: Phase I goals include analyses and proof-of-concept experiments.

Phase II: Phase II goals include demonstrating flight-qualified, flight-ready hardware.

Dual Use Commercialization Potential: Much of the "more electric" aircraft technologies have application to civilian aircraft markets as well as electric vehicle uses and commercial power generation, motors, switching, and electrohydraulic/electromechanical actuator industries.

AF94-181TITLE:Power Electronics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Explore and develop power electronic devices, components, and systems for future 1 kW-150 kW aeronautical power system applications.

DESCRIPTION: Proposals should address the development of power electronic devices and components for aeronautical power system application in the power range of 1 kW to 150 kW. Candidate device and component technologies should demonstrate advances in efficiency, power density, and high temperature (greater than 200 degrees C) operation.

Phase I: Phase I goals include analyses and proof-of-concept experiments.

Phase II: Phase II goals include detailed analytical deviations and prototypical devices, components, or hardware demonstrations. Phase III goals include demonstrating flight-qualified, flight-ready hardware.

Dual Use Commercialization Potential: Much of the technology is of direct interest to future commercial utilization by the automotive, power generation, and motor drive industry where high temperature operation, high current fault tolerant switching, and/or high reliability are required.

AF94-182TITLE:Advanced Energy Conversion and Power Sources

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Characterize and apply advanced energy conversion materials.

DESCRIPTION: Proposals should address the characterization and application of advanced energy conversion materials for aerospace power system application, including aircraft, tactical weapons, life support, survival equipment, and remote basing.

Phase I: Phase I will focus on characterization of properties of these materials as related to envisioned applications and quantitative assessment of realizable improvements of system performance.

Phase II: Phase II goals will focus on improvement of properties, batch manufacturing methods, and demonstration of the material in a prototypical configuration. Phase III is expected to transition the Phase II products to a specific application via design, resolution of unresolved production and manufacturing issues, or complete

demonstration of material compatibility, life, or properties for a specific application.

Dual Use Commercialization Potential: All the technologies of interest have direct relevance to commercial applications related to energy storage, pulse power for medical or scientific diagnostic equipment, mobile/portable power systems. The commercial applications must also consider affordability in the market place.

AF94-183TITLE:Development of Lubricous Coatings and Composites for Bearings and Separators

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop lubricous coatings and self-lubricating, light-weight composites suitable for gas turbine engine bearing use.

DESCRIPTION: The Department of Defense is currently developing advanced gas turbine engines under the Integrated High Performance Turbine Engine Technology (IHPTET) program that will require lubrication systems to operate from -60 degrees F to 1500 degrees F. Improved lubrication methods, such as self-lubricating mechanical components (i.e., self-contained solid lubricated bearings) are critical for achieving these goals. Currently, there is no satisfactory method of achieving consistent and durable lubricant supply and/or replenishment in self-contained solid lubricated bearings. Additionally, the bearing cage or rolling element retainer has been identified as a limiting component in most of these bearings when operating at high speeds and temperatures.

Phase I: Phase I of this research effort shall investigate the feasibility of using advanced high temperature solid lubricants and high strength composite material technology for developing improved lubricous coatings and a light-weight/high-strength/self-lubricating cage material for high-temperature/high-speed bearing applications. The suitability of such materials shall be demonstrated for use as durable, effective tribiological coatings and self-lubricating bearing cage materials.

Phase II: Phase II activities shall include development, detailed design, fabrication, and full characterization of selected lubricous coatings and self-lubricating bearing cages. Facilities, including a 60,000-rpm bearing test rig, available at Wright Patterson Air Force Base may be proposed for characterization of selected bearing concepts. Under Phase III the small business shall team with a bearing manufacturer to develop this technology into a viable, marketable product. The ultimate payoff for the Air Force will be the development of a solid lubricated system that will either eliminate the need for or only require a smaller, lighter weight delivery system. Either way, the successful completion of this program will result in a lighter weight lubrication system resulting in increased performance critical to achieving IHPTET goals.

Dual Use Commercialization Potential: The material and/or coatings developed in this effort have many excellent opportunities for dual use in the private sector. Potential commercialization opportunities range from automobile bearings to small and large appliances requiring wear resistance on sliding surfaces.

AF94-184TITLE:Fuel Combustion Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Demonstrate concepts that improve gas turbine combustor performance goals and design methodology.

DESCRIPTION: The processes important to conventional gas turbine combustion are atomization and evaporation of

liquid hydrocarbon fuels, mixing of the fuel vapor with air, and ignition and complete burning of the mixture. These processes should occur very rapidly so that the combustor operation is stable and efficient over a wide range of fuel and air flow rates, consume all the fuel, can be easily ignited at ground and altitude conditions, have an acceptable temperature profile at the combustor exit, and are suitable for the development of a low specific fuel consumption and high thrust-to-weight ratio engine. These characteristics must be achieved in such a way that pollutant emissions of nitric oxides, carbon monoxide, total hydrocarbons, and soot are low at all conditions and the combustor is affordable, has high reliability, and has a long operating life without maintenance. Innovative combustor concepts are sought that will improve performance in gas turbine combustors. Such concepts might include catalytic combustion, methods for rapid atomization and mixing of fuel and air, ways of converting liquid hydrocarbon fuel to gaseous or supercritical fuels in the fuel system, and techniques for efficient injection and burning of these fluids in the combustor. Concepts for high performance low nitric oxides emissions are of particular interest. Next generation combustor design models are also of interest. These could include probability distribution function models, large-scale simulations with improved turbulence, transport, liquid sheet break-up, and atomization models. Improvements in advanced diagnostic techniques that would provide information for making design decisions are also of interest.

Phase I: Phase I efforts should experimentally demonstrate, on a laboratory scale, the potential of a combustor concept or diagnostic technique to improve the performance characteristics of the device as compared to a suitably chosen state-of-the-art concept. Computational support of the concept is advantageous but not sufficient for a Phase I effort. Likewise, potential improvements in computational models must be demonstrated by comparison with state-of-the-art techniques for configurations where experimental data are available.

Phase II: Phase II efforts should provide complete demonstration of significant performance gains and affordability in the combustor concept, model, or diagnostic technique for an application of interest to the Air Force.

Dual Use Commercialization Potential: A high performance, low emissions gas turbine engine combustor is of high value in both military and commercial markets. High performance, manifested in high thrust-to-weight and low specific fuel consumption, affect the economics of operating a competitive commercial aircraft fleet. However, the current commercial market for aviation gas turbine engines is driven by the level of their exhaust emissions. Public attitudes and local legislation have made low emissions a dominant issue, even at the expense of other performance parameters. Technology that yields low engine emissions, while preserving high performance, will dominate in both military and commercial markets.

AF94-185TITLE:Vapor Lubrication of Gear and High Velocity Sliding Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop vapor lubrication processes and systems for gear and high velocity sliding mechanical components.

DESCRIPTION: Vapor phase lubrication proved promising for high temperature bearing systems, but application to high velocity sliding and high load mechanical systems, such as gears, cams, and pistons has not been done. Systems such as turbine engine gearboxes and adiabatic diesel engine cylinders and cams are prime candidates for use of vapor lubrication. Also, systems that currently use solid or grease lubricants could potentially benefit from increased load carrying capacity of vapor deposited films which can lift lubrication out of the boundary and into elastohydrodynamic (EHD) regime. This rapidly developing technology can reduce weight and complexity of current liquid lubricated systems and has potential to increase performance and life of current solid and grease lubricated systems.

Phase I: Phase I activities shall include proof of concept and testing of promising vapor lubricants under high velocity sliding and high load conditions within simulated or actual gear, cam, or piston systems. Load carrying capacities and probable operating temperature range for various vapor lubricants in each of these systems shall be determined. A report of the feasibility of vapor phase lubrication for application in systems to replace liquid, solid, or grease lubricants shall be prepared.

Phase II: Phase II effort shall include testing of real high temperature, high load gear and other systems, probably in teaming with engine manufacturers. Design and installation of prototype vapor lubrication systems for evaluation in actual engine test programs is very desirable. Design and testing of real vapor lubrication systems in advanced turbine gearbox, diesel, or other high sliding, high load systems is expected as the major product of the Phase II effort.

Dual Use Commercialization Potential: Vapor lubrication has excellent commercial technology transfer potential for future automotive engines in upper cylinder wall and piston ring lubrication. Cylinder wall lubrication in high temperature diesel engines and gear lubrication in high load transmissions are also possible. Industrial gas turbine bearing and gear systems could benefit from more thermodynamically efficient high temperature operation made possible by vapor phase lubrication.

AF94-186TITLE:Aero Propulsion and Power

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Improve performance and reliability or maintainability of propulsion and power technologies.

DESCRIPTION: The Aero Propulsion and Power Directorate (APPD) pursues research and development in four principal areas: Turbine Engines, Fuels and Lubrication, High-Speed Propulsion, and Aerospace Power. The Turbine Engine Thrust centers on the Integrated High Performance Turbine Engine Technology (IHPTET). Associated studies are conducted in compressor research, turbulent flows, gas generators, and uses of composite materials for lightweight, high temperature and low signature applications. The Fuels and Lubrication Thrust addresses challenges introduced by IHPTET for thermal management and high temperature lubrication. Milestones for 1994 are fuels that operate at ambient temperatures up to 425 degrees F and lubricants up to 625 degrees F. Associated work uses computational fluid dynamics and fuel chemistry programs to promote thermal advanced designs, new endothermic fuels, and improved combustors. The third thrust addresses the technologies for high-speed atmospheric flight relevant to the turboramjet (for high Mach speeds) and to missile variable flow ducted rockets and boron-based solid fuel ramjets (for missiles). Thrust from development emphasizes the more-electric airplane, and concepts for generation and distribution of mechanical, electrical, hydraulic and thermal energy. Associated work responds to the need to increase aircraft power levels and reliability. Advanced fault tolerant power systems, power inverters, and efficient batteries provide the infrastructure for these requirements.

Phase I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing to demonstrate the potential merits of the concept.

Phase II: Provide detailed analytical derivations and prototypical device/or hardware demonstrations.

Dual Use Commercialization Potential: The higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable commercial propulsion and power generating systems. The modular engine concepts and new fuels and lubricants developed under this program are suitable for integration into new engines for commercial use or as retrofits and provide low cost, easily maintained systems. The power developments transition naturally into emergency power sources for large installations, disaster preparedness and efficient utilization of natural gas that is presently flared.

AF94-187TITLE:Physics of Plasma Processing

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Explore and characterize the plasma physics fundamentals governing interfaces produced by plasma-enhanced deposition.

DESCRIPTION: Proposals should address plasma processing and plasma-enhanced deposition science which is used in making diamond and diamond-like thin films for power semiconductors, thermal control surfaces and mechanical surface treatments. These fundamentals also apply to disposal of hazardous substances.

Phase I: Phase I efforts will focus on identifying physical mechanisms and limitations governing important interfaces and their processing parameters (e.g., uniformity, topography, rates of deposition, defects) related to the plasma, surface interaction problems.

Phase II: Phase II efforts will focus on demonstrating process control and validating improvements. Phase III efforts will demonstrate specific device applications of the improved plasma processing.

Dual Use Commercialization Potential: Plasma deposition processes are pervasive in the commercial semiconductor industry. Therefore, proposals should focus on those aspects of the deposition process which will have direct transfer applicability to commercial processes. Along with deposition processes for semiconductors, commercial application of these processes for applying coatings and insulation are important.

AF94-188TITLE:Voice Controlled Computing Environment Assistant

CATEGORY: Basic Research

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Provide a complete automated semantics based voice operated (No Hands) assistant for office environment.

DESCRIPTION: The basis of this research is to establish an environment that is capable of performing routine office activities such as E-Mail, word processing, spreadsheet, and telephone message processing using voice and/or sound context semantics processing. Maximum use of commercially available heterogeneous hardware, software, voice synthesis, and natural language processing will be used. Multiple dialects of each language must be processed. The processing scenario should include the computer system start up, application processing, data acquisition and update, storage and retrieval and communications (computer to computer/computer to human) must be accomplished through voice and/or sound semantical interpretation and generation. The lexicon must be rich enough to support a manufacturing production office processing technical and business data.

Phase I: Establish voice computing environment assistant (VCEA) requirements and provide project documentation. Establish the VCEA solution concept and survey industry for available technology. A prototype will be built to validate the VCEA. A technical review board (TRB) will be established for VCEA of potential vendors and end users. Prepare a detailed plan for Phase II.

Phase II: During this phase a production version will be designed and built of VCEA, documentation will be provided, and the design and components will be reviewed with TRB for VCEA. Demonstrations of VCEA will be performed and a training course will be established on each VCEA component. Vendor commitments are to be explored and commitments obtained where possible to produce and market the VCEA components. Standards requirements for the VCEA component technologies will be developed and utilized. A copy of engineering documents and software will be provided.

Dual Use Commercialization Potential: The VCEA has dual use in all areas where computers are interfaced directly (local or remote) with human beings or other audio capabilities. Some specific examples of dual use are:

a. Voice activated telephone, ATMS, household appliances, amusement devices, etc.

b. Transportation vehicle accessories, universal locator, guidance and control systems, unmanned vehicle management (ground, air, water, space, etc.)

c. Design and repair of human, animal and automated equipment systems by audio assistance to the performer of complex procedures lead through in all phases (analysis, disassembly, maintenance, reeducation, testing, return to service process, etc.)

d. Education, training, emulation, simulation, etc.

e. Security is an inherent feature for defense and civil use (voice and speech pattern recognition etc.).

AF94-189TITLE:Modeling for Sensor-Based Semiconductor Process Control

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop models for sensor-based control of single wafer silicon microelectronics processes.

DESCRIPTION: Recent developments in microelectronics manufacturing have emphasized a high flexibility concept, including single wafer processing in cluster tools, sensor-based, closed loop process control, and factory automation. Indeed these concepts have already been demonstrated. In order for the industry to fully benefit from the implementation of these concepts, continuing advancements are needed in the area of modeling for real-time process control. Typical single wafer processes requiring tight control for silicon device fabrication include chemical and physical vapor deposition, plasma processes, and rapid thermal processes. This solicitation seeks to develop models which will work in conjunction with sensor data to calculate optimal machine settings for the processes mentioned above. The goal is to drive each process to its target.

Phase I: This effort will involve the development of models for sensor-based control of single wafer silicon microelectronics processes.

Phase II: Will include verification of models with actual manufacturing processes, further modification of models as necessary, and planning for the implementation of the models into production.

Dual Use Commercialization Potential: Single wafer processes have been developed for semiconductor processing which has both military and commercial application. Single wafer processing is ideal for low volume production (military and commercial), such as for application specific devices, prototypes, and large diameter wafers, and is also scalable for high volume production, as is typical for commercial commodity parts. Sensor-based process control and modeling optimize the quality and throughput of these processes.

AF94-190TITLE:Improved Machining Precision with Neural Network Technology

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop neural networks to improve the machining of materials.

DESCRIPTION: Machining errors have systematically been individually addressed with traditional engineering methods. Separate machine design and compensation strategies have been used to reduce static and dynamic deflection, tool wear, control following errors, machine alignment, and general process errors. Artificial neural network has been used to model thermal distortion error. As yet, a comprehensive inclusive strategy has not emerged which collectively addresses all these errors. The need exists to extend neural network capability to comprehensively include all machining errors in a composite fashion.

Phase I: Will research the approach required to an overall composite machining error compensation

methodology using artificial neural network. The research should demonstrate how such an overall approach would improve precision machining in a general machine shop environment. The research should build upon recent projects which use neural network techniques for error compensation predication, and demonstrate improved precision by actually machining simple parts. Phase I should also include an assessment of both the technical and commercial viability of using artificial neural network in machining and provide a clear justification for continuation into Phase II.

Phase II: Will extend the Phase I research to investigate production level applicability with a detailed cost benefit analysis compared to the state of the art.

Dual Use Commercialization Potential: Machining of materials is the heart of the industrial base. This technology is not specific to military requirements. Improved precision machining using neural network technology and artificial intelligence can be benefitted by industries ranging from aerospace to automotive to medical.

AF94-191TITLE:Ceramic Matrix Composite Processing Simulation

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Investigate the processing of advanced high-temperature ceramic matrix composites using computer simulation.

DESCRIPTION: Achieve revolutionary advances in turbopropulsion-powered systems for the next century, advanced high-temperature ceramic matrix composites will be required. Processing of these materials into complex three-dimensional components is often the primary impediment to producing fully dense, defect-free hardware. Fabrication to these advanced materials is still being accomplished by traditional trial-and-error methods. Rarely does this approach lead to an optimized process which yields high quality components at the lowest manufacturing cost. Both oxide and nonoxide ceramic matrix composites are being investigated for potential near term military use as high as 1300 degrees centigrade. Stability at temperatures up to 1925 degrees centigrade are necessary for future civil applications.

Phase I: Will investigate the feasibility of applying computer simulation and materials modeling to the manufacturing processing of advanced high-temperature ceramic matrix composites. Feasibility shall be demonstrated on simple components to show proof of concept.

Phase II: Will build upon the Phase I work to include complex three dimensional shapes and introduction of an intelligent processing of materials approach.

Dual Use Commercialization Potential: Ceramic composite materials are required in ground-based power systems, nuclear power systems, space power systems, and automotive applications. Modeling and process simulation will lead to lower cost manufacturing and increased use of this specialty material. The most immediate application of this technology would be for the future High Speed Civil Transport (HSCT). The HSCT expects to use extensive amounts of ceramic matrix composites for the combustor and exhaust sections. Advanced process simulation can assist in significantly reducing manufacturing costs.

AF94-192TITLE:Carbon-Carbon Manufacturing

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Demonstrate preproduction manufacturing methods for producing low cost carbon-carbon composites.

DESCRIPTION: The use of carbon-carbon composites for such applications such as thermal protection, thermal management of both structures and electronic components, and high temperature components has inhibited the cost of manufacturing these components and limited lifetimes demonstrated to date in oxidizing environments. Coating and other protective systems are available and emphasis is needed on cost to manufacture.

Phase I: Will investigate the use of advanced or innovative materials and processes that hold great potential for the densification of fibrous preforms at a very low cost. The process duration should be measured in days as opposed to weeks and months as is the current state of the art.

Phase II: Would continue to investigate promising materials and processes to eliminate the least promising and determine the limits or constraints characteristics of the Phase I selected materials and processes.

Dual Use Commercialization Potential: Due to the thermal management characteristics of C-C composites, they offer significant potential use in the commercial electronics world. The high temperature features of these composites also allow their use in commercial aircraft engines as well as automotive engines. The inert properties of C-C also make them candidates for prosthetic devices in the medical world.

AF94-193TITLE:Acquisition Management Information Analysis Center (AMIAC)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop a process which allows interchange between software tools and integrates technical, business, management and logistics data.

DESCRIPTION: The Acquisition Management Information Analysis Center (AMIAC) is implementing a library of acquisition management tools to provide professional management support services to its customers. The delivery of databases, database processes, format of information, and specific software tools is the objective of this effort. The goal is to focus on a process to improve productivity without getting the user involved in the detail of the data and storage.

The continuing need to upgrade the office systems (both hardware and software) to utilize the benefits of evolving technology is a critical cost driver. Unfortunately, most of the time very little of the existing system or data can be salvaged without extreme cost, and is thrown away. Therefore systems need to be designed with change and evolution in mind.

Phase I: An open framework design and prototype that facilitates the exchange of data and graphical information between software tools.

Phase II: An open framework implementation that forms a library of acquisition management tools (i.e. process, software, project/program schedules, etc.) needed for acquisition management, integration of technical, business, administrative, and logistics data; and independent integrated databases to manage data and information. The framework must use graphical user interfaces, interprocess communication, process flow management, database management, design-data management, configuration management, programmatic language interface, graphical programming environment that helps merge CALS, EDI, Knowledge Bases, and Expert System efforts to enhance the utilization of development tools and information to management requirements.

Technical Challenge: Must implement an open framework to achieve the integration and exchange of technical, business, logistics, and administrative data. This management tool must have the ability to link software packages of programs, exchange data between programs, and install new capabilities through the use of graphical interfaces without the need for onsite programmers.

Dual Use Commercialization Potential: The potential applications of this phase must be addressed in detail. This technology has potential applications in any business application that requires information exchange between a variety of software tools and databases (examples: Insurance, Banking, Legal, Concurrent Engineering.) A detailed marketing plan for this phase must outline commercial viability and define how commercial ventures will be pursued.

AF94-194TITLE:New Concepts and Innovations for Aeronautical Systems/Subsystems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop new concepts and innovations for aeronautical systems/subsystems for projected emerging and existing systems.

DESCRIPTION: This topic covers all facets of aeronautical systems/subsystems research, development, and acquisition necessary to address the Functional Capability Requirements/Needs outlined in the industrial version of the Aeronautical Systems Center FY94 Planning Guidance-Systems Descriptions, 23 Dec 92. This general topics covers the full spectrum of Air Force aeronautical missions (i.e. tactical, airlift, mobility, strategic, hypersonics, tactical relocatable targets, etc). Emphasis is placed on potential long-term concepts which address affordability, supportability, maintainability, survivability, etc. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some representative topics areas are:
Air vehicle:Low maintenance, all weather/night, etc.
Airframe: Minimum weight, etc.
Structures: Damage tolerant, inspectable, reduced manufacturing cost, composites, etc.
Aerodynamics: High lift, Low drag, etc.
Flight Controls:Fly-by-wire/light, reduced weight integrated redundant/self repairing, etc.
Landing Gear:Reduced parts, no jack required, etc.
APU: Self start, extended operation, etc.
Cargo: Rapid load/unload, multiple configurations.
Engines: High T/W, improved SFC, FOD resistant/tolerant, reduced IR/noise signature, integrated w/flight controls, etc.

This topic is structured to provide a maximum of innovative flexibility to prospective participants.

Phase I: In the Phase I proposal briefly address the anticipated Phase II effort and the anticipated commercial application the potential for Phase III.

Dual Use Commercialization Potential: Each proposal must address the dual use, 'Commercial Potential', of the concept/technology presented.

AF94-195TITLE:Campaign-Level Modeling for Assessing Theater Airlift Capability

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop campaign-level modeling for tool assessing theater airlift capability.

DESCRIPTION: An analytical capability is needed to assess U.S. Military's needs for theater airlift and its impact on warfighting effectiveness. This effort will form a core of mission area assessments (MAA), mission needs analysis (MNA) and cost and operational effectiveness analyses (COEA) tools for acquisition of future theater airlift systems and concepts. Key to this capability is a validated campaign-level model which incorporates theater airlift systems, concepts, and technologies in conjunction with airland battles, and surface logistics transportation. Supporting tools and models may be necessary to assess the impact of airlift factors at the mission level to provide data for the campaign-level analysis. Examples of airlift factors are airlifter characteristics, command and control capability, material handling capability and maintenance and ground support capability. The principal focus on this modeling

capability is to provide insight into the impact of theater airlift on warfighting effectiveness. The methodology, with varied databases, can provide a capability for commercial aviation assessment of productivity, cost and efficiency.

The effort will begin with a study of the analysis requirements and an identification of the key processes to be modeled. These processes must be documented in a flowchart with narrative. The second task will construct a comprehensive approach for analyzing theater airlift capability and its impact on war fighting effectiveness. The third task will be to complete a thorough survey of existing analytical tools and sources of data, which could have applicability and where they fit into the overall process identified in task two. The survey will include the organization responsible for model/database, system requirements, and its primary use. The fourth task will assess the capability to model the various elements of the processes defined in task two and recommend enhancements needed to existing models and additional models to be developed. The final task is an overall plan for SBIR Phase II including recommended activities and schedule leading to a full analysis capability. The final product of Phase I is a thorough documentation for the above tasks.

Dual Use Commercialization Potential: The analysis approach and many of the models (e.g., cargo loading models) resulting from this effort has high potential for use in the optimization of commercial transport operations and systems.

AF94-196TITLE:Sensor Fusion Modeling to Support Combat Identification (CID)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop an analytical tool to access multi-spectral sensor fusion.

DESCRIPTION: Provide the Air Force with analytical tools to access the contribution of unambiguous, multi-spectral sensor fusion to mission success and fratricide reduction.

The SBIR contractor must demonstrate an understanding of CID technology developments to define the analysis requirements. The contractor will perform a survey of existing sensor fusion studies. The contractor will derive and document an analysis approach and develop a prototype model to demonstrate the feasibility of his solution. The identification fusion process must include sensor information from both on-board and off-board sensors. Activities necessary to provide a full analysis capability will be detailed in a comprehensive plan for Phase II and documented in a final report.

Dual Use Commercialization Potential: The model has civilian/commercial application. This analytical tool can be used to access multi-sensor data requirements necessary for identification and positive position tracking of civil air traffic.

AF94-197TITLE:ENSIP Inspection of Engine Components

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an Engine Structural Integrity Program (ENSIP) Inspection system that does not require cleaning parts.

DESCRIPTION: Under current ENSIP guidelines, large areas of the engine parts must be inspected for flaws in the .03 inch to .07 inch range and some selected small areas down to .01 inch. Currently a combination of Fluropenetrant

Inspection (FPI) and Eddy Current (EC) techniques are used to perform these inspections. The major drawbacks of both of these inspections systems are that parts must be cleaned to an "as new" condition, the FPI process is labor intensive, and EC is slow. The cleaning process itself is a labor intensive effort. In addition, numerous hazard substances are currently used in this process. The use of these chemicals will be prohibited in the future, and we need to be able to reduce our usage of them in the near term. There are several new inspection technologies, such as Magneto Optic Eddy Current Imaging and Laser Holography, that may be able to inspect the parent metal in the part without cleaning the part. The major difficulties with the inspection of engine parts is the flaw-size inspection requirements and the complex geometries of the parts. Also, due to the high volume of parts and accuracy requirements of the inspections, a rapid automated system is mandatory.

Phase I: Recommend the best technology to solve the ENSIP Inspeciton problem and demonstrate that technology in the engine depot inspection environment.

Phase II: Develop an automated inspection system that can demonstrate the image processing techniques that are required to build a production automated system.

Dual Use Commercialization Potential: FAA is considering the addition of this type of inspection. However, the use of this technology goes far beyond the ENSIP inspection requirements. This type of inspection is required of all new engines to ensure flaws are not present. Currently this inspection is done immediately after machining and prior to finishing. Industry requires a process by which they can inspect completed parts.

AF94-198TITLE:New Concepts and Innovations for Aeronautical and Support Equipment FACTS Parts

CATEGORY: Basic Research

OBJECTIVE: Develop FACTS parts to improve reliability/maintainability of existing and emerging aeronautical systems and support equipment.

DESCRIPTION: FACTS parts are the small hardware items that make up the mechanical infrastructure of aircraft and support equipment, they are the: fasteners, relays, connectors, hand tools, seals, etc. In contrast to the reliability gains in electronics and engines, the reliability improvements of FACTS items has been static. The topic in innovative concepts is intended to cover all facets for acquisition of aeronautical and support equipment of FACTS parts research and development. It is intended to provide latitude to the innovator to include areas not addressed by other specific aeronautical or FACTS topics. Innovations in technologies that are currently available only from foreign sources or from limited sources in the United States are specifically encouraged. Additionally, innovation proposals which address Logistic Technology Needs are encouraged. Some areas of interest are improvements to fastening systems and electronic connectors. This topic is structured to provide a maximum of innovative flexibility to the prospective participants.

Phase I: The Phase I proposal should address/convey a good understanding of the current problem, potential solutions and the anticipated Phase II effort and potential for Phase III.

Dual Use Commercialization Potential: Many FACTS items such as fasteners and connectors are common to both commercial and military aircraft and their associated support equipment. FACTS maintenance problems are generally the some for both military and commercial operators. Improvements in the reliability and maintainability of military FACTS items, will have direct application to commercial aviation fleets. The goal of any proposed solution should be its acceptance as a commercial standard.

AF94-199TITLE:Innovative Control Effectors for Hypersonic Vehicles

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative flight control effectors to increase control power for hypersonic vehicles.

DESCRIPTION: Present hypersonic vehicle designs lack adequate control power from conventional elevators, rudders, and ailerons to stabilize and control the vehicle at every speed without imposing large performance penalties. Additionally, propulsion systems require close tolerances on angle of attack and sideslip during normal flight operations and demand even closer tolerances during maneuvering flight. In order to control the vehicle with such precision, there is a need to develop innovative control effector concepts that will generate forces and moments to stablize and control hypersonic vehicles. These concepts should be effective in generating forces and moments at vehicle speeds ranging from take off to hypersonic cruise to landing. Direct gas jet control effectors, also known as reaction control systems, are not considered new and innovative. The amount of time needed to generate the forces and moments should be similar to the response time of a conventional control surface deflection.

Phase I: Identify concept, show feasibility, show superiority to conventional movable surfaces and gas jets.

Phase II: Develop concept, demonstrate via wind tunnel testing and computational fluid dynamics.

Dual Use Commericalization Potential: Conventional aircraft, STOL aircraft, space launch systems.

AF94-200TITLE:Advanced Copper Heat Exchanger Structure

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop high thermal conductivity heat exchangers for use at 1400 oF to 1500 oF.

DESCRIPTION: The engine structures for future aerospace vehicles (e.g. NASP) will operate in severe thermal and acoustic environments. In order to meet vehicle performance goals, lightweight actively cooled structures are needed. To survive in the high heat flux environments, high thermal conductivity in the short transverse direction and a high conductivity coating are required. To reduce component weight, the material strength must be maximized. This combination of requirments leads to a need for heat exchanger structures which have the short transverse thermal conductivity of copper and a high temperature strength approximately twice that of copper.

Phase I: Demonstrate appropriate architectures with desired thermal conductivity and strength.

Phase II: Fabricate and test appropriate heat exchanger subelements in representative environments.

Dual Use Commercialization Potential: Conventional aircraft, automobile radiators, air conditioners.

AF94-201TITLE:Damage Tolerance of Structural Ceramic Composites

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop damage tolerance analysis methods for structural ceramic composites.

DESCRIPTION: The damage tolerance and residual strength analysis of structural ceramic composites including Carbon-Carbon, C/SiC, and SiC/SiC composites with geometric discontinuities such as cracks and notches is complex due to their anisotropic properties and inhomogeneous make-up, damage initiation, growth, and failure modes. Structural life and strength prediction methods for these materials are required to assure structural integrity of hypervelocity vehicles.

Phase I: Demonstrate the concept of the method.

Phase II: Develop the method should be fully and verify by tests under cyclic loads and temperatures.

Phase III: A marketable computer code for damage tolerance analysis of aerospace structural ceramic composites should be available.

Dual Use Commercialization Potential: Materials for automobile engines, materials for gas and steam turbines, structural materials for buildings, bridges, etc.

AF94-202TITLE:Emerging Technologies Resulting in Lighter Aircraft, Increased Engine Performance, and Improved Design Tools

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Improve aircraft structure, scramjet performance, and aerodynamic design technologies

DESCRIPTION: The National Aero-Space Plane is providing a quantum jump in aerospace technologies by investigating new and innovative solutions. Its goal is a Mach 25 air-breathing scramjet vehicle capable of single stage to orbit. Emerging technologies providing significant performance improvements for the aircraft will be considered. Computational fluid dynamics, materials science, and scramjet performance are of special interest.

Phase I: Show experience and understanding of the relative importance of the technologies. Provide detailed drawings, specifications, and test procedures for the proposed application of the technologies.

Phase II: Prototype and associated test results demonstrating decreased weight, increased scramjet performance, or improved aerodynamic design tools without increased liabilities.

Dual Use Commercialization Potential: The NASP Industry Team, Government laboratories, the computer industry, and the automotive industry, commercial aircraft manufacturers.

AF94-203TITLE:Develop High Temperature Hydraulic Fluid for Engine and Flight Controls of Hypersonic Vehicles

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop high temperature hydraulic fluid for engine andflight controls of hypersonic vehicles.

DESCRIPTION: The fluid needs to be usable from -54oC to 315oC. It must be a fully formulated, thermally stable fluid containing antiwear and antioxidant additives or demonstrate equivalent performance.

Phase I: Selection and bench test demonstration of the appropriate base fluid and performance improving additives into a prototype fluid.

Phase II: More extensive bench evaluation, pump evaluation, and demonstration of pilot plant fluid production.

Dual Use Commercialization Potential: Commercial aircraft, ground equipment for arctic use.

AF94-204TITLE:Nondestructive Evaluation of Advanced Materials Substructures

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop nondestructive evaluation (NDE) techniques formatrix and reinforcing substructures in advanced composite materials.

DESCRIPTION: Advanced innovative approaches are needed to develop new and improved nondestructive evaluation techniques for the detection, imaging, and characterization of flaws and other integrity-reducing anomalies in flight vehicle and engine materials, including metals and metallic and nonmetallic matrix composites. Improved techniques are also needed for real-time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed to determine the condition of matrix and reinforcing substructures in advanced composite materials.

Proposed technical approaches must clearly and significantly improve current standard techniques used in factory or field inspections, or must identify new inspection and evaluation technologies far superior to current techniques. The technologies have the potential for ultimate use in realistic materials development, manufacture, or in-service environments.

Phase I: Initial formulation, fabrication, and evaluation of specific NDE techniques for demonstrating the concept.

Phase II: Development for optimization of the techniques investigated in Phase I and to bring the technique or equipment to a marketable state.

Dual Use Commercialization Potential: Materials for automobile engines, materials for gas and steam turbines, structural materials for buildings, bridges, etc.

AF94-205TITLE:Armament Research

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air delivered non-nuclear munitions and armaments. These include bombs, submunitions, warheads, projectiles, fuzes (including safe and arm devices for air-to-air missiles), dispensers, seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid-state inertial components, exterior ballistics, lethality and vulnerability assessment techniques, and conventional weapon environmental, demilitarization and disposal techniques. Some examples of desired research are: low drag/observable weapon airframes; conformal/internal carriage techniques; millimeter wave-seekers for mid-course and terminal guidance; sensor fusion; self-forging fragment warheads; shaped charges; long-rod penetrators; reactive fragment warheads; computational fluid dynamics including interactive grid-generation techniques, and warhead hydrocode-assessment techniques; hard-target weapon technology; and autonomous guidance.

Dual Use Commercialization Potential: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

AF94-206TITLE:High Explosives for Combined Military/Commercial Application

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop commercially producible high explosives for use by the military and/or industry.

DESCRIPTION: Military explosives, for the most part, exhibit good performance characteristics, have long shelf-lives, require special production facilities, are not easily removed from warheads or rendered inert, and are generally not environmentally friendly during manufacture or demilitarization. Considerable effort is still being put forth by the military to develop new explosives or formulations with increased performance, e.g. increased blast or detonation pressures. While new materials are being developed and some increases in performance are being achieved, only minor progress is being made in the environmental areas of demilitarization and hazardous waste reduction. Commercial explosives, on the other hand, usually do not exhibit properties that are considered compatible with military objectives or safety requirements, e.g. long shelf-life, small critical diameter and high performance. Examples of these explosives are the aqueous emulsions used primarily by the mining industry. The primary goal of this program is to develop a new energetic material or formulation that exhibits the performance and safety properties required by the military, is suitable for use by both the military and industry, can be produced relatively cheaply in non-specialized (commercial) facilities, and that is easily demilitarized and rendered inert with minimal effect on the environment. Phase I of this program includes small scale characterization tests on selected formulations and selection of two or more formulations for further testing in Phase II. Areas of importance for this initial selection are cost of materials, production characteristics associated with ingredients, formulation and demilitarization issues, hazardous waste minimization, and predicted performance characteristics. Phase II of this program will demonstrate the usefulness of selected formulations to the military and industry through appropriate testing. All issues are to be addressed including performance, safety, shelf-life, cost, producibility, and environmental concerns.

Dual Use Commercialization Potential: Explosive formulations developed under this program should be shown to have commercial potential in mining, blasting, demolition, oil and gas exploration, and/or excavation. This program is considered to be a "spin-on" Technology Transfer demonstration.

AF94-207TITLE:Motion Video and FPA Digitization and Compression Chip-Set

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop an application specific integrated circuit (ASIC) chip-set that will digitize, compress, and modulate fast motion video and focal plane array waveforms.

DESCRIPTION: A subminiature telemetry technology has been developed that will collect up to 64 analog and l28 digital, low bandwidth data types, serialize, encrypt, and microwave transmit the data to DOD ground stations. While this baseline technology meets requirements for telemetering weapon fuzing and many other functions, it does not meet requirements for telemetering focal plane array (FPA) and full motion video seeker information. Simultaneously, efforts to miniaturize high speed, high resolution charge coupled device imagers for aircraft and weapon testing have resulted in a need to transmit the resulting high bandwidth data. In all cases, encryption is a driving requirement, implying that the analog video and FPA data be digitized. Efficient use of the telemetry transmission spectrum is also a driver, suggesting that unique data compression and modulation techniques be applied to decrease transmission bandwidth while maintaining image quality. Several levels of quality must be defined, each dependent upon the specific application. Real-time compression (lossless and lossy) and transmission is also a requirement for some applications. This entire functionality must be developed, then miniaturized to be captured entirely within a monolithic chip-set that will integrate and function with the subminiature telemetry chip-set. Programmability of the chip-set is

desired so that one product may satisfy many applications. Phase I of this program will begin by studying the various applications and requirements for the chip-set. It is envisioned that one or more commercial applications will be included in the requirements study. The subminiature telemetry technology must be thoroughly studied to ensure eventual compatibility. Algorithms and architectures (including those of existing products) will be studied to determine what best meets the requirements. In Phase II, one or more breadboards will be constructed and demonstrated in the laboratory, both isolated from and interconnected with a subminiature telemetry module. Miniaturization methods will be researched, compared, and recommended.

Dual Use Commercialization Potential: In Phase III, prototype chip-sets will be produced, packaged in a multi-chip module, and tested. Integration with the subminiature telemetry will be accomplished. The sponsor will demonstrate the prototype in a flight test program. At the completion of this program, the chip-set will be available for dual use in commercial applications such as communications, telemetry, and space.

AF94-208TITLE:Sabot Design for High-Velocity Projectile Launch

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop sabot design principles for projectile testing in aeroballistics research facilities.

DESCRIPTION: The Aeroballistics Research Facility (ARF) at Eglin AFB performs tests on a wide variety of projectiles ranging from small caliber munitions to subscale missile models. Projectile velocities vary from Mach 0.4 to Mach l0. A significant amount of data is lost and substantial damage to the ballistic range occurs due to poor sabot separation from the projectile. Experience has shown that some sabot designs work well at high velocities but perform poorly at low velocities. No criteria allowing the test engineer to properly match launch environment to sabot design presently exist. Although literature discussing sabot design for various applications exists, no systematic literature review and distillation of sabot design principles has been done. A handbook detailing sabot design principles for a wide range of launchers and launch velocities would formalize what is presently a trial and error process. Successful definition of sabot design principles could reduce lost data and prevent projectile damage to range equipment. Phase I includes an in-depth search for sabot designs required to identify concepts for aeroballistic testing. As a result of this search a preliminary set of design guidelines will be determined. Phase II includes building and testing various sabot designs to validate preliminary design guidelines developed in Phase I. A test program will be carried out to develop design principles for concepts identified for further research in Phase I. The second phase should produce a sabot design handbook based on analysis of literature and the Phase II test program.

Dual Use Commercialization Potential: A better understanding of sabot design and application will allow more complex and fragile models to be tested in interior ballistic ranges. Well designed sabots will allow approximation of aerodynamic properties of new aircraft and missile configurations from scale models fired in the ballistic range. Many configurations can be quickly and inexpensively evaluated prior to expensive wind tunnel testing of larger instrumented models. Improved sabot technology will make the interior ballistic range an important aircraft and missile design tool which will pay-off for the commercial aerospace industry. Possible joint programs between the Air Force and industry may develop in this area.

AF94-209TITLE:Solid State Flight Data Recording

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Investigate design architectures exploiting high density packaging of random access memory circuits to provide transient recording of high speed digital data.

DESCRIPTION: This area of research will exploit advances in high density/low power random access memory and 3-dimensional integration via high density interconnect. The goal is to achieve a data cache that can support data rates of l5 gigabits per second. The driving requirement is to develop a modular approach for the memory packaging and input/output support circuitry that can be used in embedded telemetry systems, survivable event records (fuze-well), and for high speed imagery/electronic signal recording. For instance, parallel output image sensors are under development for infrared and visible imaging which have 2 to 64 outputs with pixel rates up to 50 MHz each, and dynamic range of 4 to l6 bits per port. A typical requirement for this type of sensor entails several channels of data flowing in at l0 to l5 gigabits per second with a total storage requirement of from l to l0 seconds. The driving requirements for this technology are density (l0 seconds in less than l50 cubic inches), power, and cost comparability to current instrumentation recording technologies. The other main requirement is to survive the high G shock environment of a weapon penetration through a target or launch from a gun barrel. Phase I should consist of an architectural design considering several commercial approaches for Multi-Chip Module (MCM)/Laminated Substrate or other high density integration of memory devices. Producibility aspects will be considered as well as unit cost. Deliverables will be designs, simulations, samples of the system components, and proposals to bread/brassboard modules into candidate demonstration systems in Phase II. Phase II will refine the proposed designs from Phase I and fabricate medium density breadboard and limited capability brassboards for actual environmental and operational testing. Sensor acquisition front ends will be adapted in Phase II to provide proof-of-concept for eventual Phase III customers.

Dual Use Commercialization Potential: Phase III will develop and package modules for customer specific technical applications in sensor data and weapon performance recording as well as commercial applications in high performance computing, telecommunications, entertainment and environmental monitoring.

AF94-210TITLE:Remote Holographic Interferometry System (RHIS)

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Produce remote holographic interferograms of outdoor dynamic events involving weapons test.

DESCRIPTION: Great progress has been made by the holography community in developing pulsed holographic interferometry. This remote holographic interferometry system (RHIS) should provide high resolution holograms and interferograms. To produce an interferogram, an initial hologram must be produced of the test arena with no disturbances. Next, a second exposure must be made of the test arena while an actual event is occurring. This provides a true 3-dimensional view of the event and the capability to observe fragments (formation and impact), projectiles (missiles), and structures (impact damage). The interferogram results from combining the undisturbed hologram with the distribute hologram of the same interest field. The fringe patterns on the interferograms provide important flow diagnostic information around projectiles and fragments. It also shows the stress and strain of impact between projectiles and structures. This system is needed to produce holograms and interferograms in the following areas: projectiles (missiles) striking large concrete and/or steel structures; detonation of shaped charges and warheads; and other explosive events at test ranges. Phase I of this SBIR task is to design potential techniques to apply this technology to outdoor testing facilities where the test equipment is located beyond lethal range. The task will provide a preliminary system design, proof of principle tests, and recommendation of a candidate approach to be demonstrated in Phase II. Phase II is expected to produce a prototype to demonstrate the outdoor feasibility and resolution of the holograms and interferograms. This task will also develop a quantitative data reduction package.

Dual Use Commercialization Potential: Phase III is expected to package the prototype from Phase II. This

Remote Holographic Interferometry System can ultimately be manufactured and can be used on all DOD test ranges and for commercial structural and vehicle testing.

AF94-211TITLE:Active RF Microwave/Millimeter Wave Raw Data Fusion

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Exploit data fusion techniques for an active microwave and millimeter wave RF multi-sensor seeker.

DESCRIPTION: Multi-sensor raw data (signal level) fusion offers the potential to enhance detection performance of missile seekers for air targets in clutter and in countermeasures. This data fusion technique leads to a new system that fuses the sensor observations before declaring a detection and provides for full integration of each sensor observation. Fusing of dissimilar sensor data from millimeter wave and infrared sensors has already shown a wide variety of improved gains over varying environmental conditions - from l0 decibels (dB) in correlated clutter conditions to less than a tenth of dB in other conditions. Similar improvements are anticipated for raw data fusing of active RF microwave and millimeter wave sensors. Present solutions to overcome these difficulties are too inflexible to be generally adaptable to a large number of scenarios and applications. An artificial neural network can increase the efficiency of correlation and track fusing of multisensors by being independent of any explicit data processing algorithms and "learning" the algorithms. Application of an artificial neural network to raw data fusion of similar and dissimilar sensor data should also improve their fusing efficiency. A neural network's flexibility and adaptability to accommodate operational variances for many conditions and targets may significantly enhance the success of raw data fusing of a microwave and millimeter wave sensor suite. Phase I of this SBIR program includes identifying artificial neural network systems appropriate for this data fusion task. If appropriate, an abbreviated artificial network will be developed to demonstrate the concept. Detailed analysis of candidate friendly air target signatures and phenomenology, observational conditions, and microwave and millimeter wave sensor's characteristics will be done leading to the development of processing parameters and a raw data fusion algorithm to dictate a design and an implementation. Phase I will culminate in a non-real time demonstration of the implementation of a raw data fusion algorithm using an artificial neural network with several synthetic generated microwave and millimeter wave multi-sensor data sets. Phase II of this SBIR program will develop and fabricate a real time artificial neural network to demonstrate this raw data fusion implementation. A large number of synthetic microwave and millimeter wave data sets will be generated for training sets to teach the network.

Dual Use Commercialization Potential: A demonstration of commercial applications of this technology such as in smart vehicles, transportation routing, commercial space and commercial air will take place in Phase III. A commercialization plan will be required in Phase II.

AF94-212TITLE:Diode Laser for Use in Low Cost Laser Radar Applications

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a diode laser to be used as the source of a low cost eye safe laser radar system.

DESCRIPTION: Current laser radar systems have experienced a great deal of success using solid state media as the laser's source. Diode lasers have been considered as a source in an effort to reduce the cost and weight of these systems.

Currently diode lasers with wavelengths longer than l.4 micrometer have limited peak power and poor beam quality. The goal of this program is to design and develop a diode laser and associated driver circuitry with high peak power, high pulse repetition frequency (PRF), and good beam quality. To lower the cost of the overall laser radar system the laser should operate in the l.4 to 26 micrometer region. This will allow room temperature detectors to be used in the system. A line width of less than 4 nanometers is required. The pulse repetition frequency should be at least 5 kilohertz, preferably higher. We are interested in approaches that result in good beam quality as compared to master oscillator power amplifier (MOPA) configurations used in GaAlAs devices. Phase I of this SBIR task is to conduct a search of potential materials that could be used to make the diode laser that will meet the above criteria. A preliminary design of the diode laser will be presented. Phase II of the SBIR is to manufacture and deliver three diode laser and driver units from the Phase I design. Additionally, a unit production cost estimate will be accomplished to demonstrate that the diode laser is a low cost alternative to diode pumped solid state lasers.

Dual Use Commercialization Potential: Commercial applications of this technology will also be pursued during Phase II. Many possible areas of application exist such as control systems, low cost commercial radar (both airborne and ground based), and medical applications. A commercialization plan will be required in Phase II.

AF94-213TITLE:Composite Weapon Technology

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop reliable composite weapon production and inspection processes and repairability methods

DESCRIPTION: Before composite materials will be fully accepted and utilized in future weapon systems, it is imperative that quality control issues, such as process repeatability, process controllability, non-destructive inspection, environmental
susceptibility, and repairability issues be defined and designed into future systems. Previous technology programs have demonstrated the potential of composite materials to lower the weight and cost of systems. Up to a 30 percent savings in cost and weight is achievable through application of composite materials rather than metal. However, variances in production tolerances, uneven wet-out, and temperature control has resulted in varying strength and stiffness properties. Also, uncertain susceptibility to environmental conditions, and undefined methods for non-destructive evaluation and repairability, prevent composite materials being readily used for production of weapon airframes. Phase I of this program will include design and development of techniques to eliminate the problems associated with production, inspection, environmental exposure and repairability of composite weapon airframe components. Phase II of the program will implement the techniques of Phase I through production of prototype major weapon components such as uppershell, lowershell, or dispense tubes. Selected NDI/NDE techniques, quick repair methods, and accelerated environmental test will be used to demonstrate process improvement.

Dual Use Commercialization Potential: Commercial Phase III payoff will transition this technology to the automotive, aircraft and boat manufacturing industries. A commercialization report will be required in Phase II.

AF94-214TITLE:Weapon Design Optimization

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop weapon shaping optimization methods employing interactive techniques or optimal control

theory.

DESCRIPTION: Designing aerodynamically advanced weapon airframes is often a trial-and-error process involving wind tunnel testing on a variety of candidate configurations. This process is very long and tedious and also quite expensive. Traditional theoretical optimization methods use calculus of variations to solve aerodynamic shaping problems. This procedure is too cumbersome especially when applied to three dimensional, full vehicle design optimization. Interactive solution techniques involving linear and/or non-linear programming methodology offer potential to solving weapon design problems by minimizing the difference between desired aerodynamic performance and those predicted by an aerodynamic code on a configuration that is interactively determined. Of specific interest is subsonic/transonic design regime. Another potential method is using optimal control theory to optimize vehicle design. Traditionally used in missile autopilot design, optimal control theory can be extended to vehicle design problems by changing the control and performance variables used in autopilot control schemes. Either of the techniques could be extended to other than aerodynamic optimization. They could also be applied to optimizing radar cross section performance or structural performance. Ideally, the problem could be solved from a multivariable approach that optimizes overall vehicle performance. Phase I of the program would evaluate optimization schemes as described above and select a preferred method. In Phase II algorithm development will be accomplished for the aerodynamic optimization problem, and several test cases will be evaluated. Algorithm development for radar cross section and structural optimization will be accomplished and a complete multivariable optimization code will be developed.

Dual Use Commercialization Potential: Commercial Phase III payoff will be investigated in the aircraft, automotive, and the civil engineering industry. A commercialization plan will be required in Phase II.

AF94-215TITLE:Compact Ultra-Short Pulse Antenna for Fuzing

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a shock-survivable, compact antenna for radiating and receiving extremely transient pulses.

DESCRIPTION: It is desired to transmit and receive fast rising (less than l00 picoseconds) short duration (less than l50 picoseconds) transient pulses of electromagnetic energy. The antenna must occupy a volume of 500 cubic centimeters or less and accommodate ultra-wideband radiation effectively. The Air Force is envisioning the use of these ultra-short pulses for fuze sensing applications. Since this is an emerging immature technology, new designs quite different from many traditional antenna structures will be needed to meet the requirement. In addition to the antenna design, it may be necessary to develop a sound and viable basic model to analyze and describe interactions of an ultra-short electromagnetic pulse. This model should be able to analyze and predict many observed reflection and transmission processes adequately. Only a limited number of studies describing the interaction of these pulses with solid material exist. Particularly, its reflection from the front and back interfaces of solid matter and the transmission characteristics through layers of material are of keen interest. Phase I of this program would emphasize design and modeling of the proposed antenna along with proof of principle experiments. Characteristics (size, strength, shock-survivability, operating limitations) of the proposed design should be defined. Phase II of the program will emphasize an optimization of antenna parameters, antenna fabrication, and experimental verification in the actual working environment. Any model developed should be optimized and verified with experimental results.

Dual Use Commercialization Potential: Although the Air Force is interested in this technology for fuzing applications, many commercial uses exist if the state of the art can be pushed to allow sensing to l50-200 foot depths. Geological surveys for mineral deposits would be possible. Civil engineering applications such as determining underground utilities, buried structures, building layout, and city planning are realistic. Environmental engineering applications include site surveys, locating buried waste and reclamation.

AF94-216TITLE:High Blast Explosives

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop explosives with improved, metal-induced blast characteristics resulting from high detonation temperatures

DESCRIPTION: The military has routinely added metals to explosive fills in the form of particles, sponge, liners or follow-through to improve blast, cratering, heave, bubble energy or incendiary characteristics and other, more easily oxidized, longer reacting metals for incendiary purposes. Typical examples for the latter purpose are zirconium, both sponge and liners, titanium sponge, mischmetal liners and depleted uranium follow-through. Aluminum additive reacts with an oxidizing medium, e.g. detonation products, oxygen in the air or, perhaps, oxidizing functional groups associated with the explosive fill, to tailor the rate of energy delivery by the expanding detonation gases. Success in both blast-type and incendiary areas has been achieved, the degree of which depending on specific goals. The formation of aluminum oxide (Al203) is extremely exothermic and can effectively be used to increase the temperature of the expanding detonation products and influence the distribution of the equilibrium products. A detrimental aspect in using aluminum is that the oxide coating associated with each particle does not slough off with increasing thickness. The primary goal of this effort is to develop an explosive fill incorporating particulate metal that provides improved air blast, cratering, or heave properties over those of existing explosives. Sensitivity to shock, fragment or flyer plate-like impact and those forces associated with hard target penetration must be minimized. Phase I would include a comprehensive search for candidate energetic materials/formulations that will cause the complete and rapid oxidation of incorporated particulate metal during detonation. This search should cover a range of conditions that may provide insight into the effective use of metal as an air-blast, cratering, or heave enhancing agent when incorporated into a specially designed explosive. Initial syntheses of new energetic materials with the predetermined characteristics should be formulated.

Environmentally friendly materials and procedures must be utilized during this development and environmentally sound demilitarization procedures should be proposed. Phase II would include synthesis/formulation work and the necessary testing to verify the new explosive as having improved blast/cratering/heaving characteristics. Issues to be addressed include performance, sensitivity, and environmental soundness.

Dual Use Commercialization Potential: Commercial applications of the explosive developed under this program will be persued. Applications include spin-off to the mining, blasting, and demolition fields. A commercialization plan will be developed in Phase II.

AF94-217TITLE:Role of Strain Hardening on Directed Energy Warhead Performance

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Understand strain hardening during liner production and warhead formation and methods of improving warhead performance

DESCRIPTION: All metals of interest for Explosively Formed Penetrator (EFP) application experience strain hardening to varying degrees during manufacturing and penetrator formation. In order to adequately describe the constitutive equations of state used in design, it is necessary to gain a better understanding of the forming processes and input the results and knowledge gained into these equations. For example, strain hardening that occurs during tantalum

liner production is known to have significant effect on the formation behavior of the warhead. If we are to understand the strain hardening process that occurs during penetrator formation, it is absolutely necessary to understand manufacturing processes. The scope of this work effort should be restricted to copper and tantalum. Phase I will result in an understanding of strain hardening during manufacturing/processing and present new and novel concepts of the role of strain hardening in penetrator formation. The final report should demonstrate both the feasibility and validity of the technical approach to integrate strain hardening effects in design and production of metal liners. Phase II will apply the newly developed concept and equations of state to predict warhead performance. A test program will be used to verify predicted improvements. The product should be a new and unique approach relating manufacturing proceses for directed energy warhead liners to design and performance.

Dual Use Commericialization Potential: Additional emphasis is placed on the utility of the resultant approach for non-DOD commercial applications. Phase III is expected to produce results applicable to related areas such as tool and die manufacturing, space vehicle, and manufacturing processes. A commercialization plan will be required in Phase II.

AF94-218TITLE:Photoinitiated Explosives

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop an explosive photoinitiated by high intensity coherent light.

DESCRIPTION: The Air Force needs safer, less sensitive explosives. To this end, an explosive is desired that can be initiated solely by the excitation of a particular chromophore in the molecule/formulation. In principle, the explosive would be undetonable unless excited by a particular frequency and with a high intensity of light. Fuses and boosters can be redesigned for simpler operation with this technology. Perhaps a biphotonic transition could be exploited. Such an explosive, could, in principle, be simultaneously detonated throughout its volume, as contrasted with normal explosives which are initiated at one end. Phase I will be comprised of a comprehensive search for energetic materials with the appropriate electronic transitions and for photosensitizers that might be used to indirectly excite these transitions. Experiments will be designed to demonstrate the feasibility of the system. Phase II will demonstrate the practicality of the system and develop an economic analysis. Complete testing should be conducted on candidate systems. Environmental aspects of recommended systems will be documented.

Dual Use Commercialization Potential: Commercial applications for the explosive formulations will be sought. Possible applications include mining, blasting, and demolition. Photoinitiated explosives would allow safer operation in these applications. A commercialization plan will be delivered in Phase II.

AF94-219TITLE:Narrow Band Receiver For Optical Fuzing

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Demonstrate a narrow band receiver that can track the center frequency of a diode laser as its output frequency varies over temperature.

DESCRIPTION: Optimization of the signal-to-noise ratio for optical fuze sensors is needed for the sensor to meet more demanding performance requirements. Overall sensor performance could be increased with improved optical filter/detector combinations that have more desirable operating characteristics. Optical bandpass filters are used to limit the amount of background energy that can impinge the detector elements. Two considerations when using these devices are the diode laser frequency change versus temperature and the acceptance angle of the received energy. Diode laser devices have a significant center frequency shift versus temperature when compared to the ideal bandpass filter required to optimize system signal-to-noise ratio. Active temperature control of the diode lasers is not an option; therefore, the device needed is a bandpass filter or filter/avalanche photodetector combination that can be configured to track the frequency changes of the diode laser versus temperature. A passive technique would be preferred, but active techniques that could be operational at fuze power-up (less than 50 microseconds) would be acceptable. The final technique needs to work with diode lasers that range from 800-970 nanometer wavelength and should be no larger than current interference filter techniques. Although the current acceptance angle of interference filters is adequate, a device with a larger acceptance angle would also be preferred. The Phase I program design should show feasibility of the concept and minimum package size along with baseline operating characteristics. Phase II of the program would emphasize construction of several demonstration devices and testing to show bandpass filter tracking operation over the temperature range.

Dual Use Commercialization Potential: Commercial applications for the technology developed will be sought. Possible areas of applications are space communications, optical processing, and medical instruments. A commercialization plan will be developed in Phase II.

AF94-220TITLE:Parallel and Distributed Processing for Vulnerability Simulations

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop innovative techniques utilizing parallel and/or networked distributed processors for vulnerability simulations on workstations and PC computers.

DESCRIPTION: Weapon lethality and target vulnerability methodologies have been developed and used over the past several years to assess weapon performance. The complexity of targets, weapon delivery conditions, and a broad range of kill mechanisms lead to very large numbers of vulnerability/lethality assessments that must be performed to accurately quantify the effectiveness of a weapon or system. Presently, the Warheads Branch of the Wright Laboratory Armament Directorate has a study underway that requires 500,000 individual sub-simulations on four computers over eighteen months. The results of the vulnerability assessments are required in the weapon design/redesign process. This can only occur if the assessments are run in a timely manner. Recent developments in the computer industry might be applied to reduce vulnerability assessment run times and thus affect design decisions. The Phase I effort should characterize various platforms (including workstations and personal computers) and connectivity methods for performance criteria affecting
parallelization/distribution. Computer languages such as FORTRAN 90 should be addressed. With an understanding of the class of problem (vulnerability simulations), the development and evaluation of different approaches for solving distributed parallelization should be performed. A recommendation of the best approach(es) for the determined criteria should be made and a limited prototype developed. Phase II would complete the design and development of the prototype and demonstrate its applicability. If more than one prototype is recommended because of the differences in workstations and personal computers, several will be characterized.

Dual Use Commercialization Potential: Phase III involves the commercialization of the approach(es) (less the vulnerability methodology) which, if successful, would be readily adaptable to a variety of computing environments and classes of problems. A commercialization plan will be developed in Phase II.

AF94-221TITLE:Reagent for N-NO2 Scission

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a reagent to safely demilitarize nitramine explosives

DESCRIPTION: The Air Force has a vast inventory of nitramine based explosives (HMX, RDX, tetryl). Demilitarizing these could be a laborious, costly, and dangerous procedure. We desire a reagent to gently break the N-NO2 bond in these compounds, rendering them less dangerous or inert. Concentrated sulfuric acid can effect this cleavage (probably via protonation of the amine nitrogen and subsequent loss of nitronium ion), but it poses a serious disposal problem. The reagent of choice will be environmentally benign or readily recycled. Phase I will be comprised of a comprehensive search and preliminary small scale screening of proposed reagents against model nitramines. The best two or three reagents will be selected for larger scale studies based on cost, efficiency, yield, and "environmental friendliness." Phase II includes scale up to kilogram scale on the model nitramines, small scale studies on actual nitramine explosives, and development of an economic analysis of the process.

Dual Use Commercialization Potential: Phase III will scale up explosive treatment to kilogram scale and demonstrate commercial feasibility of the full scale process. A commercialization report will be required in Phase II which should outline other possible applications such as environmentally safe recycling of nitramine based compounds.

AF94-222TITLE:Interdisciplinary Optimal Design of Advanced Missile Airframes

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a multidisciplinary optimization scheme involving Computational Fluid Dynamics (CFD), structural statics and dynamics, heat transfer, and Radar Cross Section (RCS) analysis.

DESCRIPTION: The study of advanced missile airframes involves computer aided analysis of structural response involving statics, dynamics, and heat transfer. In addition, the low observable properties of candidate missile designs must also be taken into consideration, the primary concern being minimization of RCS. CFD is also used to compute air loads. Multidisciplinary optimization can be used to consider several effects by the use of direct or indirect methods, creating an objective function. Appropriate constraints can then be applied and the design problem can then be solved. As of now, the multidisciplinary design optimization tools for finite element analysis for structural statics and dynamics currently exist, however, there is no coherent approach for considering all relevant effects in a fully three dimensional problem. CFD can be used to give the loadings on a body in flight. Finite element analysis is the usual approach taken to perform computer oriented structural studies. A displacement oriented approach is typically used to solve for structural static and dynamic effects. Heat transfer analysis results in a temperature distribution profile and heat fluxes. RCS analysis obtains an equivalent cross section, usually measured in decibels per square meter. The technical challenge is the combination of all of these effects into one design optimization scheme which would include three dimensional effects. Phase I of this SBIR is to search for methods of optimization and identify and report on the most appropriate approach for three dimensional multidisciplinary analysis. An outline of the proposed computer code together with some working modules is expected from Phase I. Phase II of the SBIR task is expected to create a three dimensional code that can be used as a tool in multidisciplinary design studies. Shape optimization should also be considered. The code will be tested against a broad class of problems involving the design of advanced missile airframes.

Dual Use Commercialization Potential: Phase III is expected to produce a commercially acceptable code, compatible with MSC/NASTRAN finite element models. It should be capable of interfacing with a commercially available graphics pre- and postprocessor such as MSC/XL or PATRAN.

AF94-223TITLE:Recycling of Advanced Composite Materials Used in Weapons Systems

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Determine recycling methods and applications for advanced composite materials used in weapons systems.

DESCRIPTION: Advanced composite materials are being increasingly used in weapon systems because of their strength, stealthy qualities, and other desirable characteristics. Currently, composite materials are disposed of in landfills with little regard for environmental effects or considerations for reuse. With the increasing quantities of these materials being used in munitions, the selection of materials and the recycling/reuse potential of the materials are of increased importance for environmental, waste minimization, and life cycle cost considerations. This task will involve identifying the composite materials used in weapon airframes and warheads, and then investigating and demonstrating the reuse/recycling of these composite materials in an environmentally acceptable manner. Reuse and recycling considerations for the selection of composite materials will be identified and made available to weapons designers for incorporation into new weapon system designs/technologies. Phase I of this SBIR task includes a survey of the composite materials used in weapon systems, e.g., airframes and warheads and analysis of possible approaches to recycling and secondary or alternate use strategies. Phase I will culminate with a report on the potential strategies for reuse and recycling of the various materials with the advantages and disadvantages associated with the methods discussed. The Phase I report will recommend one or more promising candidate approaches for further investigation in Phase II. Phase II will consist of further investigation and small scale demonstrations of candidate reuse and/or recycling technologies. The most promising technology(s) will be recommended for a Phase III pilot study. A recycling/reuse considerations guide for the composite materials investigated will be produced.

Dual Use Commercialization Potential: In Phase III, potential applications to industry will be identified and a small pilot plant demonstration will be conducted to further validate the most promising recycling/reuse technology(s). The knowledge gained by completing this task would be of great interest to other users of composite materials such as the automotive industry and makers of recreational equipment.

AF94-224TITLE:Reclamation/Recycle of Depleted Uranium and Heavy Metal Alloy Residue from Soils

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Provide an environmentally safe reclamation/recycle technology for recovery of depleted uranium and heavy metal alloys from soil.

DESCRIPTION: Many thousands of tons of munitions in the Air Force inventory contain depleted uranium (DU) as a weapons component. Other uses of DU as warhead materials will generate larger quantities in the near future. In addition, other heavy metals such as tungsten and tantalum are being developed as warhead materials by the services. Contamination of the soil with DU and other heavy metals as a result of test and evaluation is a major problem within

the Department of Defense (DOD) and Department of Energy (DOE). Disposal of DU in low level radioactive waste disposal sites is becoming increasingly expensive and alternatives to disposal have not been developed and demonstrated. This project will allow DU and other heavy metals from conventional munition test firings to be recovered from soils and recycled, thus avoiding burial. Cost of new materials and disposal combine to make new methods of recovering heavy metals from soils essential. The recovered materials may be used for other military or commercial applications while reclaiming the test site for
unrestricted use by DOD and DOE. The goal of this task is to identify and/or develop a technology to recover DU and heavy metal alloys from soil and recycle them. The primary emphases of this effort should be removal of particle sizes less than two millimeters. The goal of this program is to reduce soil contamination to less than six micrograms of DU per gram of soil. Phase I of this SBIR will consist of an analysis of recovery/recycle methods for heavy metal alloys from contaminated soil. Methodology for recovery and recycle will be demonstrated in Phase II. During Phase II, implementation will be demonstrated by recovering and recycling DU and other heavy metal alloys using the selected process.

Dual Use Commercialization Potential: Depleted uranium and other heavy metals can be recycled for many commercial applications such as heavy equipment counterweights, ballast in aircraft and armored cars, radioactive shielding, and as balance weights for drill collars, tool holders, and flywheels. A commercialization plan will be required in Phase II.

AF94-225TITLE:New Approaches to Conductive Polymer Engineering

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Explore new methods for developing conductive polymers and to characterize their behavior with regard to electrical conductivity, chemical stability/compatibility, and mechanical processability.

DESCRIPTION: Past efforts in conductive polymer development have generally involved doping of available polymers to achieve non-insulating behavior. This is often accompanied by drastic changes in physical and mechanical properties. New experimentation/ theoretical approaches are needed to further develop conductive polymers to suit a broad range of applications. Starting from fundamental premises, the Phase I effort should be to develop and verify a method to create new polymers with enhanced conductivity, thermoplasticity, and chemical stability. It may be possible to understand the behavior of junctions between different conductive polymers using models applicable to conventional diode junctions. Carrier generations, Fermi levels, and optical absorption/emission are important considerations for such models. Potential end products for Phase II development are multilayer polymer film infrared sensors or photovoltaic cells and high surface area polymer electrodes for double layer capacitors.

Dual Use Commercialization Potential: Commercial applications include low cost IR sensors and low cost power sources for retail products. A commercialization plan will be developed in Phase II.

AF94-226TITLE:Sealed Bipolar Lead-Acid Battery

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a compact lead-acid battery which does not have individually partitioned cells but instead consists of a sealed multicell stack.

DESCRIPTION: The problem of miniaturizing the standard lead-acid battery may be overcome with modern technology. Prior to the past decade it made little sense to attempt to do so, since it was thought that the individual cells themselves had to be vented; they were neither sealed nor maintenance-free. Having overcome this restriction, the present issue is how to fabricate anode and cathode back-to-back for a high energy density battery of a desired voltage. The two-terminal, or bipolar battery design must be extremely rugged and offer relatively high energy density. In addition, it must have a high degree of rechargeability and be well-suited to -55 degree centigrade operation for weapons application. The Phase I effort should focus upon development of a rugged l0-volt, l0 cubic centimeter device that is rigidly potted for subsequent high-G shock, low temperature testing. Phase II should explore several different battery configurations of bipolar arrangement to address a variety of military and commercial applications.

Dual Use Commercialization Potential: The sealed bipolar lead acid battery would find many commercial applications such as retail products (toys and power tools) and remote sensors and/or instrumentation packages.

AF94-227TITLE:Visualization of Circuit Card Electromagnetic Fields

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Provide a means of visually observing the electromagnetic field patterns around an active circuit card.

DESCRIPTION: Create a method by which the electric and/or magnetic fields around a circuit are translated into patterns discernible with visual spectrum light. This will provide the tester with an immediate impression of what parts of the card are active, and the level of activity. It is hoped that this image can be used to train a neural network to automatically diagnose faults in a circuit card under test. Phase I will consist of research and evaluation of potential methods for providing the image of the electromagnetic fields around the card. The best result will be graded on its resolution, passivity (does not alter fields by its presence), and speed. Phase II will generate a working model of the electromagnetic imaging system, and obtain a representative circuit card, induce faults and evaluate the ability of the imaging system to detect differences in the card. The contractor will also generate a report of the effectiveness of the technology, how it can be implemented and potential improvements.

Dual Use Commercialization Potential: This technology will have applicability to all forms of circuit card testing, both commercial and within the DOD. All circuit card manufacturers use quality control testing prior to card shipment, and major electronics firms possess in house diagnostics and repair capability. The ability to "see" the electrical and magnetic fields would provide a fast means of identifying and isolating faults on most circuit cards.

AF94-228TITLE:Development of Technologies for Environmetnal Stress Screening of Electronic Circuit Card Assemblies

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop technologies to adapt Commercial Off the Shelf (COTS) testing hardware to perform Environmental Stress Screening of electronic circuit card assemblies.

DESCRIPTION: Environmental Stress Screening (ESS) is utilized to improve the reliability of critical flight electronic hardware during its development, production, and repair life cycle process. ESS consists of functionally testing electronic hardware while applying environmental temperature or vibration stresses that simulate actual operating conditions. Currently, complex and specialized Automated Test Equipment (ATE) are the electronic stimulus and

measurement equipment that functionally test these Units Under Test (UTTS). During the ESS test troubleshooting process, there are instances where this specialized ATE can fault isolate only to a group of components within the CCA. There exists Commercial Off the Shelf (COTS) ATE that can provide functional and in circuit testing of CCAs. The following requirements are needed in order to utilize COTS ATE board/component level testers in the ESS vibration and temperature testing of CCAs: (1) capability to satisfactorily perform board level and component level testing at the operating frequency range of current applications (50 MHz maximum) and for future applications (200 MHz maximum). (2) capability to perform functional (board level) testing and in circuit (component level) testing, both with learning capability. (3) capability to properly interface the CCA to the COTS ATE and COTS ESS hardware during ESS testing without affecting performance measurement testing of the CCA, while providing the above board level and component level testing requirements. Phase I will determine the feasibility of adapting and developing interface requirements and test procedures for a jet engine controller digital microprocessor CCA of medium frequency range (less than 20 MHz) operating with and existing Government Furnished Equipment (GFE) COTS digital tester and existing GFE COTS ESS hardware and identify those COTS tester and ESS hardware and interface requirements with the greatest potential success for current (50 MHz maximum) and future (200 MHz maximum) applications. Phase II will demonstrate the concept by acquiring the integrating COTS tester and ESS hardware and developing the interface requirements for a COTS tester and ESS hardware. Test this concept under government approved acceptance test procedures.

Dual Use Commercialization Potential: The Development of Technologies for Environmental Stress Screening (ESS) of Electronic Circuit Card Assemblies has direct and immediate dual use commercial potential through the introduction of Commercial Off-The-Shelf (COTS) Automatic Test Equipment (ATE) in ESS applications. This SBIR project would have application for many DOD or commercial critical flight and field electronic hardware during its development, production, repair, and testing life cycle. This would serve to significantly reduce the cost of replacing existing obsolete ESS test equipment with faster, lower cost, and easier to maintain COTS ATE.

AF94-229TITLE:Remote Determination of Composite Chemical Characterization

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop fiber optics for chemical characterization of composite cure process in an autoclave.

DESCRIPTION: Future high performance aerospace vehicles will use composite materials extensively. Composite material costs are very high (greater than $20 per pound in the raw state and as much as $1000 per pound in a finished product). If the curing process fails, the composite must be scrapped. The development of using fiber optics in conjunction with Fourier Transform Near Infrared Raman spectroscopy is needed to allow the actual monitoring of the chemical reactions within the composite material during the cure process. If an optical fiber can be inserted into the raw composite material, then the Raman spectrum could be accumulated in real time, thereby increasing material cure reliability and efficiency.

This remote sensing technique could be used to monitor the material while curing which laboratory. Thus, provide a chemical characterization of the material while curing which would eliminate the high costs resulting from scrapping material due to improper curing. The insertion fo fiber optics into composite materials at critical stress point might also be used to monitor the internal stresses and condition of the material throughout its service life. Phase I effort will involve analysis of the theoretical background of the concept along with preliminary experiments and tests to clearly demonstrate the feasiblity of the proposed remote characterization of composite materials. Phase II will consist of the development, test, and analysis of a prototype system.

Dual Use Commercialization Potential: One use is to improve the yield rate and the useful lifespan of composites during the production of commercial aircraft. Recent studies have indicated that good use of composite products is to repair aging aircraft. So, one of the most important possibilities for process would be to allow field "patching" of corroded aircraft. Typically the failure rate of field applied composites is too high for good commercial

utilization.

AF94-230TITLE:Mass Producible, High Intensity, Subminiature, Infrared Emitters/Sources

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop the techniques required to mass produce low-cost, subminiature, high-intensity infrared sources.

DESCRIPTION: The Air Force, as well as the other services, has been developing techniques to test and evaluate infrared guided weapons by laboratory simulation. A testing method has been developed that requires a rectangular array of 64,000 to 1,000,000 subminiature infrared sources or emitters. Each DOD facility that employs this testing methodology will require an array of thousands of these emitters. The goal of this effort is to develop the components necessary to permit implementation of this method of generating real world equivalent infrared scenes. The emitters technical challenge is to successfully meet the following criteria: (1) Mass producible, orders for lots of 10,000 to 1,000,000 emitters would be typical; (2) low cost, a per bulb price of less than $1; (3) high intensity infrared output, a radiant intensity of 2.0 to 7.0 with sr measured in the 4 to 5 micron band; (4) short thermal time constant, less than 30 milliseconds; and (5) subminiature size, size same as and plug in replacement for the subminiature JKL-7376 bulbs currently on the market. Phase I of this SBIR task is to develop the required technology. Phase II of this SBIR is to further refine the emitter performance and to deliver a set of at least 300,000 bulbs, all meeting the technical requirements. The set of bulbs delivered in Phase II will be delivered in reproducing infrared video scenes from a source of RF-170 (gray scale) composite video.

Dual Use Commercialization Potential: Large arrays of these emitters will be used to evaluate air superiority and defensive systems from prelaunch through terminal impact. Potential commercial applications include precise temperature control for closed systems and convert illumination of high security areas.

AF94-231TITLE:Laser Photography of Explosive Events

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Exploit development in laser technology to design and develop a system to photograph explosive events.

DESCRIPTION: Over the last several years, the use of laser photography has been demonstrated in laboratory environments to record events for which, historically, only photography using chemical bombs for the light source has been possible. This has been done by examining the spectrum of photon emissions from the event and finding the portion of the event where the intensity level is low; selecting a laser which operates in this range; filtering a camera (or using a film which is responsive) in this range; and conducting the test. This task will transfer this technology from a laboratory environment to a standard test environment. The associated technical challenges will be many. The spectrum of the event may be broad and the intensity may be high across the frequency range. The system will need to be robust; able to survive the blast environment, able to operate in an outdoor climate, including dust, dirt, rain, humidity, etc. The cameras used will have to be those with demonstrated reliability in this environment. The laser

system used will have to be those with demonstrated reliability in this environment. Phase I of this SBIR task is to conduct a survey of the current technology in this area, analyze the spectrums of various explosive events, recommend the materials needed for a full-scale demonstration in Phase II. Phase II of this SBIR task will be to demonstrate the method defined in Phase I during actual operational tests at the 46 Test Wing. This demonstration/redesign phase will include evaluations involving different types and sizes of explosive events to fully understand the capability of the system.

Dual Use Commercialization Potential: Dual use potential will be primarily in fields where explosive devices are used, such as the oil and mining industries.

AF94-232TITLE:Contaminated Soil Remediation Utilizing Photolectric and Thermal Energy

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Chemical and Biological Systems

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Design and develop soil remediation cell which uses photoelectric energy and thermal convection.

DESCRIPTION: With the many recent technological advances in remediation of petroleum contaminated soils and more efficient photoelectric cells, the development of solar powered blowers and thermal convection to inject a controlled air flow of variable temperature into specially designed cells should now be viable. This task is to integrate existing technologies with the development of components needed for construction of 360-degree containment remediation cells that rely totally upon ambient energy storage. A constraint to the design is compliance with all applicable state and federal regulations. Phase I of this SBIR task is to design a permanent cell of approximately 1 X10-6 permeability that will contain 150 cubic yards of petroleum contaminated soil. This cell should be capable of homogeneous flow of air, yet any integral piping within the cell must be easy to disconnect as soil is removed. A convection oven would be connected in line with the blower influent line. By adjusting the rate of flow for the two parameters, the system could be used for hot-air injection, bioremediation, or combined technologies. The entire system must be ruggedly constructed, with an easily removable covering, and capable of being entered by heavy equipment. Phase I will culminate with the recommendation of a candidate system at Eglin's Receiver Landfill. Phase II of the SBIR task will be to construct a prototype cell according to design and to evaluate the remedial efficiency of the cell.

Dual Use Commercialization Potential: Petroleum contamination is the most widespread form of pollution affecting soil. With most large industries chronic discharge is inevitable, therefore commercialization of these systems provides an environmentally friendly form of remediation with no waste stream.

AF94-233TITLE:Automatic Sensor Distinguishing between Biological and Petrochemical Fuels

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an Automated sensor which can shutdown fluid-flow systems (local and remote) when dangerous levels of "foreign" combustible fluids are detected.

DESCRIPTION: Currently, illegal disposal of highly flammable and toxic petrochemical fuels into fluid flow channels causes a mission threat, as well as a health and safety danger. The development of a sophisticated sensor system which can distinguish between biological and hydrocarbon fuels would allow identification of these dangerous situations to

insure compliance with Code of Federal Regulation 40CFR. The sensor must be capable of surviving in harsh environments and contain an output capable of driving a servo system to shut down control systems and activiating an alarm system would alert disaster preparedness and environmental emergency response teams for rapid response and quick resolutation of the emergency. Phase I define the characteristics of hazardous chemicals to be detected and determine the feasibility of sensing levels of these chemicals in the presence of biological material. Phase II would develop a sensor and demonstrate the capability of detecting petrochemicals in fluid flow channels in concentrations of less than 1 part per million.

Dual Use Commercialization Potential: This sensor would have application in all major cities and manufacturing facilities for safety and early detection of dangerous conditions.

AF94-234TITLE:Treatment of Technologies for Dioxin Contaminated Soils

CATEGORY: Basic Research

DOD TECHNOLOGIES: Chemical and Biological Systems

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an innovative treatment technology and disposal technique for the treatment of Dioxin contaminated soils.

DESCRIPTION: Tetrachlorodibenzo-p-dioxin (TCDD) is produced in small amounts as an impurity used in the manufacture of herbicide compounds and products. Other known uses are for tests for flame-proofing polyesters and a method for control of insects and wood destroying fungi. However, at the present time, its primary use is in chemical research. This task is to develop an innovative treatment technology and disposal technique to eliminate dioxins from a particular location. Treatment technologies are generally defined as processes able to change or destroy contaminated materials so they are less hazardous or are no longer hazardous. Immobilizing dioxins can also be developed as a viable costs effective treatment solution. However, technical methods should be investigated first for recovery or removal such as incineration at high temperatures, oxidation destruction with the aid of a catalyst, biodegradation by fungus, photochemical destruction, and/or stabilization. Phase I of this SBIR task is to conduct a survey of existing dioxin remedial applications and techniques, in addition to exploiting new treatment technologies for recovery and removal of dioxins. Potential technologies should be reported and should include preliminary designs, advantages, disadvantages, and estimated costs for development. Finally, the Phase I task will result in a recommended concept based on research documentation and the evaluation needed to prove feasibility, including a candidate approach to be demonstrated in the Phase II task. The Phase II SBIR is to develop a treatability pilot-test to evaluate the recommended treatment technologies potential for success.

Dual Use Commercialization Potential: Development of a treatment/disposal technique for the elimination of dioxins from contaminated sites has application in many industrial, as well as military, locations.

AF94-235TITLE:Simulation of Dynamic Angle of Arrival Signals for Intercept Radars

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop an intercept radar stimulation system for evaluating directional finding capabilities in an anechoic chamber.

DESCRIPTION: Increasing emphasis is being placed upon the capabilities of modern, airborne intercept radars with electronically steered arrays to passively locate and track other aircraft with a high degree of accuracy. This supports

the need for test methods and systems capable of quantifying the performance of these radars in measuring angles of arrival for target signals under a variety of conditions. Completed studies and analysis attest to the feasibility of using signals with phase/amplitude variations from stationary sources in ground test facilities to create apparent changes in angle of arrival to a radar system under test. These techniques must be tried with real avionics components or respective emulation in a typical ground test configuration and subsequently a test guide/report and system description should be written that details the design used and approaches taken with their respective applicability and limitations. The radar field of view to be considered for the tests should be no more that 90 degrees horizontally and 60 degrees vertically. Phase I will design and develop a test system. Phase II would demonstrate a prototype system in the Benefield Anechoic Changer at Edwards AFB CA.

Dual Use Commercialization Potential: The technology of signal phase and amplitude control techniques developed for this project have application to commercial communication and television systems which employ satellites and narrow beam antenna systems.